Art of Professional Photography

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Photographer

A photographer

A **photographer** is a person who takes a photograph using a camera. This person is generally considered the artist, because he or she constructed the appearance of the product in the same way as any other visual artists. One may be an *amateur photographer* or a *professional photographer* if he or she uses photography to make a living.

The work of a photographer may be limited to the actual shooting of the camera, or it may include all of the steps in the development of the image up to the presentation of the final product. A photograph may be the work of a single person or a team. The most common teams are formed of a photographer and a laboratory technician. The laboratory work (photographic processing, image processing, plus other less common techniques) can completely change the appearance of a shot. The artistry can just as easily be in the lab work as in the shooting itself, even if the one who took the shot is more likely to be considered the artist, and the developer an artisan.

Before all a photographer is, like a painter, an artist of a vision. The technique follows, more or less faithfully, in reconstructing, even transforming, that original vision.

The photographer often has a certain personality which is expressed in his or her work. At the beginning of the photographic era, there were great debates between painters and photographers, and a great number of scholars and practicians interacted in these two areas. If photographers are considered to have "usurped" the exclusive domain of the

image from painters, painters have been profoundly influenced by the photographic technique, which obliged them to better define their domain, their subjects, and the flexibility of their technique. However, certain painters have reduced their art to that of a technician in a development lab, using another technique for copying photographs by hand.

Photographers are frequently categorized based on the subjects they photograph. There are photographers of the subjects typical of paintings (landscape, still life, portrait, etc.) as well as documentary photographers, fashion photographers, commercial photographers, etc. Some photographers specialize in a certain type of image, while others are generalists. The distinction between artistic photography and photojournalism or other types of photography and the associated techniques does not remove this personal aspect from the work of the great photographers.

Photography

Photography is the process of making pictures by means of the action of light. Light patterns reflected or emitted from objects are recorded onto a sensitive medium or storage chip through a timed exposure. The process is done through mechanical, chemical or digital devices known as cameras.

Lens and mounting of a large-format camera

The word comes from the Greek words φως *phos* ("light"), and γραφις *graphis* ("stylus", "paintbrush") or γραφη *graphê*, together meaning "drawing with light" or "representation by means of lines" or "drawing." Traditionally the product of photography has been called a photograph. The term *photo* is an abbreviation; many people also call them

pictures. In digital photography, the term *image* has begun to replace *photograph.* (The term *image* is traditional in geometric optics.)

Photographic image-forming devices

A camera or camera obscura is the image-forming device and photographic film or a digital storage card is the recording medium, although other methods are available. For instance, the photocopy or xerography machine forms permanent images but uses the transfer of static electrical charges rather than photographic film, hence the term electrophotography. Rayographs published by Man Ray and others are images produced by the shadows of objects cast on the photographic paper, without the use of a camera. Objects can also be placed directly on the glass of a scanner to produce digital pictures.

Photographers control the camera and lens to expose the light recording material (usually film or a charge-coupled device; a complementary metal-oxide-semiconductor may also be used) to the required amount of light. After processing, this produces an image.

The controls include:

- Focus of lens
- Aperture of the lens (amount of light allowed to pass through the lens)
- Focal length and type of lens (telephoto, macro, wide angle, or zoom)
- Filters, or scrims placed between the subject and the light recording material, either in front of or behind the lens
- Duration of exposure (or shutter speed)
- Sensitivity of the medium to light intensity and color/wavelength
- The nature of the light recording material, for example its resolution as measured in pixels or grains of silver halide

Camera controls are inter-related, as the total amount of light reaching the film plane (the "exposure") changes proportionately with the duration of exposure, aperture of the lens, and focal length of the lens (which changes as the lens is focused, or zoomed). Changing any of these controls alter the exposure. Many cameras automatically adjust the aperture of the lens to account for changes in focus, and some will accommodate changes in zoom as well.

The duration of an exposure is referred to as shutter speed, often even in cameras that don't have a physical shutter, and is typically measured in fractions of a second. Aperture is expressed by an f-number or f-stop (derived from focal ratio), which is proportional to

the ratio of the focal length to the diameter of the aperture. If the f-number is decreased by a factor of $\sqrt{2}$, the aperture diameter is increased by the same factor, and its area is increased by a factor of 2. The f-stops that might be found on a typical lens include 2.8, 4, 5.6, 8, 11, 16, 22, 32, where going up "one stop" doubles the amount of light reaching the film, and stopping down one stop halves the amount of light.

Exposures can be achieved through various combinations of shutter speed and aperture. For example, f/8 at 1/125th of a second and f/4 at 1/500th of a second yield the same amount of light. The chosen combination has an impact on the final result. In addition to the subject or camera movement that might vary depending on the shutter speed, the aperture (and focal length of the lens) determine the depth of field, which refers to the range of distances from the lens that will be in focus. For example, using a long lens and a large aperture (f/2.8, for example), a subject's eyes might be in sharp focus, but not the tip of the nose. With a smaller aperture (f/22), or a shorter lens, both the subject's eyes and nose can be in focus. With very small apertures, such as pinholes, a wide range of distance can be brought into focus.

Image capture is only part of the image forming process. Regardless of material, some process must be employed to render the latent image captured by the camera into the final photographic work. This process consists of two steps, development, and printing.

During the printing process, modifications can be made to the print by several controls. Many of these controls are similar to controls during image capture, while some are exclusive to the printing process. Most controls have equivalent digital concepts, but some create different effects. For example, dodging and burning controls are different between digital and film processes. Other printing modifications include:

- Chemicals and Process used during film development
- Duration of exposure (equivalent to shutter speed)
- Printing Aperture (equivalent to aperture, but has no effect on depth of field)
- Contrast
- Dodging (Reduction in exposure of certain print areas, resulting in a lighter areas)
- Burning (Increase in exposure of certain areas, resulting in darker areas)
- Paper Quality (Glossy, Matte, Etc)

Uses of photography

Photography has gained the interest of many scientists and artists from its inception. Scientists have used photography to record and study movements, such as Eadweard Muybridge's study of human and animal locomotion (1887). Artists are equally interested by these aspects but also try to explore avenues other than the photo-mechanical representation of reality, such as the pictorialist movement. Military, police and security forces use photography for surveillance, recognition and data storage. Photography is used to preserve memories of favourites and as a source of entertainment.

History of photography

Nicéphore Niépce's earliest surviving photograph, c. 1826

Sketch of the same scene

Invention

Chemical photography

For centuries images have been projected onto surfaces. Artists used the camera obscura and camera lucida to trace scenes as early as the 16th century. These early cameras did not fix an image, but only projected images from an opening in the wall of a darkened room onto a surface, turning the room into a large pinhole camera. The phrase *camera obscura* literally means darkened room.

The first photograph was an image produced in 1826 by the French inventor Nicéphore Niépce on a polished pewter plate covered with a petroleum derivative called bitumen of Judea. Produced with a camera, the image required an eight-hour exposure in bright sunshine. Niépce then began experimenting with silver compounds based on a Johann Heinrich Schultz discovery in 1724 that a silver and chalk mixture darkens when exposed to light.

In partnership, Niépce, in Chalon-sur-Saône, and Louis Daguerre, in Paris, refined the existing silver process. In 1833 Niépce died of a stroke, leaving his notes to Daguerre. While he had no scientific background, Daguerre made two pivotal contributions to the process. He discovered that exposing the silver first to iodine vapour, before exposure to light, and then to mercury fumes after the photograph was taken, could form a latent image. Bathing the plate in a salt bath then fixes the image. In 1839 Daguerre announced that he had invented a process using silver on a copper plate called the Daguerreotype. A similar process is still used today for Polaroids. The French government bought the patent and immediately made it public domain.

William Fox Talbot had earlier discovered another means to fix a silver process image but had kept it secret. After reading about Daguerre's invention Talbot refined his process, so that it might be fast enough to take photographs of people. By 1840, Talbot had invented the calotype process. He coated paper sheets with silver chloride to create an intermediate negative image. Unlike a daguerreotype a calotype negative could be used to reproduce positive prints, like most chemical films do today. Talbot patented this process, which greatly limited its adoption. He spent the rest of his life in lawsuits defending the patent until he gave up on photography. Later George Eastman refined Talbot's process, which is the basic technology used by chemical film cameras today. Hippolyte Bayard had also developed a method of photography but delayed announcing it, and so was not recognized as its inventor.


In the darkroom

In 1851 Frederick Scott Archer invented the collodion process. Photographer and children's author, Lewis Carroll, used this process.

Slovene Janez Puhar invented the technical procedure for making photographs on glass in 1841. The invention was recognized on July 17th 1852 in Paris by the Académie Nationale Agricole, Manufacturière et Commerciale.

Herbert Bowyer Berkeley experimentied with his own version of collodian emulsions after Samman introduced the idea of adding dithionite to the pyrogallol developer. Berkeley discovered that with his own addition of sulphite, to absorb the sulpher dioxide given off by the chemical dithionite in the developer, that dithionite was not required in the developing process. In 1881 he published his discovery. Berkeley's formula contained pyrogallol,sulphite and citric acid. Ammonia was added just before use to make the formula alkaline The new formula was sold by the Platinotype Company in London as Sulpho-Pyrogallol Developer.[1]

Social history

Popularization

The Daguerreotype proved popular in responding to the demand for portraiture emerging from the middle classes during the Industrial Revolution. This demand, that could not be met in volume and in cost by oil painting, added to the push for the development of photography. Daguerreotypes, while beautiful, were fragile and difficult to copy. A single photograph taken in a portrait studio could cost USD $1,000 in 2006 dollars.

Photographers also encouraged chemists to refine the process of making many copies cheaply, which eventually led them back to Talbot's process.

Ultimately, the modern photographic process came about from a series of refinements and improvements in the first 20 years. In 1884 George Eastman, of Rochester, New York, developed dry gel on paper, or film, to replace the photographic plate so that a photographer no longer needed to carry boxes of plates and toxic chemicals around. In July of 1888 Eastman's Kodak camera went on the market with the slogan "You press the button, we do the rest". Now anyone could take a photograph and leave the complex parts of the process to others, and photography became available for the mass-market in 1901 with the introduction of Kodak Brownie.

Since then color film has become standard, as well as automatic focus and automatic exposure. Digital recording of images is becoming increasingly common, as digital cameras allow instant previews on LCD screens and the resolution of top of the range models has exceeded high quality 35 mm film while lower resolution models have become affordable. For the enthusiast photographer processing black and white film, little has changed since the introduction of the 35mm film Leica camera in 1925.

Economic history

In the nineteenth century, photography developed rapidly as a commercial service. End-user supplies of photographic equipment accounted for only about 20% of industry revenue.

With the development of digital technologies and of communications devices, such as camera phones, understanding the economics of image use is becoming increasingly important for understanding the evolution of the communications industry as a whole.

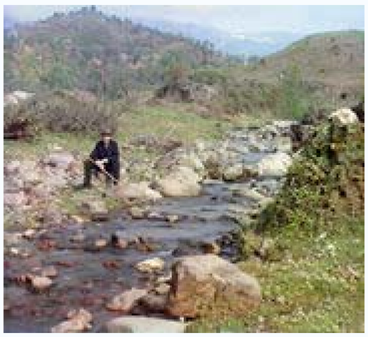
Resources

Jenkins, Reese V. *Images & Enterprise: Technology and the American Photographic Industry 1839-1925*. Baltimore, The Johns Hopkins University Press, 1975. The book provides an overview of the economics of photography and the development of the Eastman Kodak Company.

Photography types

Colour photography

Color photography was explored throughout the 1800s. Initial experiments in color could not fix the photograph and prevent the color from fading. The first permanent color photo was taken in 1861 by the physicist James Clerk Maxwell.


Early color photograph taken by Prokudin-Gorskii (1915)

One of the early methods of taking color photos was to use three cameras. Each camera would have a color filter in front of the lens. This technique provides the photographer with the three basic channels required to recreate a color image in a darkroom or processing plant. Russian photographer Sergei Mikhailovich Prokudin-Gorskii developed another technique, with three color plates taken in quick succession.

Practical application of the technique was held back by the very limited color response of early film; however, in the early 1900s, following the work of photo-chemists such as H. W. Vogel, emulsions with adequate sensitivity to green and red light at last became available.

The first color film, Autochrome, invented by the French Lumière brothers, reached the market in 1907. It was based on a 'screen-plate' filter made of dyed dots of potato starch, and was the only color film on the market until German Agfa introduced the similar Agfacolor in 1932. In 1935, American Kodak introduced the first modern ('integrated tri-pack') color film, Kodachrome, based on three colored emulsions. This was followed in 1936 by Agfa's Agfacolor Neue. Unlike the Kodachrome tri-pack process the colour couplers in Agfacolor Neue were integral with the emulsion layers, which greatly simplified the film processing. Most modern color films, except Kodachrome, are based

on the Agfacolor Neue technology. Instant color film was introduced by Polaroid in 1963.

As an interesting side note, the inventors of Kodachrome, Leopold Mannes and Leopold Godowsky, Jr. were both accomplished musicians. Godowsky was the brother-in-law of George Gershwin and his father was Leopold Godowsky, one of the world's greatest pianists.

Color photography may form images as a positive transparency, intended for use in a slide projector or as color negatives, intended for use in creating positive color enlargements on specially coated paper. The latter is now the most common form of film (non-digital) color photography owing to the introduction of automated photoprinting equipment.

Digital photography

Having fun with **photography**: manipulation of the scanned print in a graphics program puts these two "brave" people on top of an Austrian cable car. Click on the picture to see the three pictures used.

Traditional photography was a considerable burden for photographers working at remote locations (such as press correspondents) without access to processing facilities. With increased competition from television there was pressure to deliver their images to newspapers with greater speed. Photo-journalists at remote locations would carry a miniature photo lab with them and some means of transmitting their images down the telephone line. In 1981 Sony unveiled the first consumer camera to use a CCD for imaging, and which required no film -- the Sony Mavica. While the Mavica did save images to disk, the images themselves were displayed on television, and therefore the camera could not be considered fully digital. In 1990, Kodak unveiled the DCS 100, the first commercially available digital camera. Its cost precluded any use other than photojournalism and professional applications, but commercial digital photography was born.

Digital photography uses an electronic sensor such as a charge-coupled device to record the image as a piece of electronic data rather than as chemical changes on film. Some other devices, such as cell phones, now include digital photography features.

Although not viewed by all photographers as true photography, digital photography in fact meets all requirements to be called such. Even though there are no chemical processes, a digital camera captures a frame of whatever it happens to be pointed at, which can be viewed later. In 10 years, digital point and shoot cameras have become widespread consumer products. These digital cameras now outsell film cameras, and many include features not found in film cameras such as the ability to shoot video and record audio.

Kodak announced in January 2004 that it would no longer produce reloadable 35 mm cameras after the end of that year. This was interpreted as a sign of the end of film photography. However, Kodak was at that time a minor player on the reloadable film cameras market. In January 2006 Nikon followed suit and announced that they will stop the production of all but two models of their film cameras, they will continue to produce the low-end Nikon FM10, and the high-end Nikon F6. On May 25, 2006 Canon announced they will stop developing new film SLR cameras.[2] The price of 35 mm and APS compact cameras have dropped, probably due to direct competition from digital and the resulting growth of the offer of second-hand film cameras.

Ethical concerns arise when discussing digital photography. Many photojournalists have moral reasonings not to crop photos and are forbidden from combining elements of multiple photos to make "illustrations," passing them as real photographs (for example, the photo above of the two men on the cable car). Many courts will not accept digital photographs as evidence as they are easily modified. Today's technology have made picture editing relatively easy for even the novice photographer. While photography editing software may raise ethical issues, even beginners can easily edit color, contrast, exposure and sharpness with the click of a mouse, whereas those same procedures would have taken an extensive amount of time in a traditional darkroom.

Digital versus film

There is debate over which of the two formats, digital or film, is superior. It cannot be said that either of the formats is superior to the other in every way. Rather, each of the formats has its own specific advantages. This section discusses those points.

Quality

A long exposure photograph of an aircraft about to land at Indira Gandhi International Airport, Delhi, taken from Indian Statistical Institute, Delhi centre

There are numerous measures which can be used to assess the quality of still photographs. The most discussed of these is spatial resolution, i.e. the number of separate points in the photograph. This is measured by how many millions of picture cells make up the photo.

The comparison of resolution between film and digital photography is complex. Measuring the resolution of both film and digital photographs depends on numerous issues. For film, this issue depends on the size of film used (35 mm, Medium format or Large format), the speed of the film used and the quality of lenses in the camera.

Additionally, since film is an analogue medium, it does not have pixels so its resolution measured in pixels can only be an estimate.

Similarly, digital cameras rarely perform to their stated megapixel count. Other factors are important in digital camera resolution such as the actual number of pixels used to store the image, the effect of the Bayer pattern of sensor filters on the digital sensor and the image processing algorithm used to interpolate sensor pixels to image pixels. In addition, digital sensors are generally arranged in a rectangular pattern, making images susceptible to moire pattern artifacts, whereas film is immune to such effects due to the random orientation of grains.

Estimates of the resolution of a photograph taken with a 35 mm film camera vary. However, there exist many estimates around 12 megapixels.[3] [4] It is possible for more resolution to be recorded if, for example, a finer grain film is used or less resolution to be recorded with poor quality optics or low light levels. The analysis of R. N. Clark leads to this conclusion: "The digital megapixel equivalent of film is highly variable and roughly depends on film speed. Slow, fine-grained 35mm films with speeds of ISO 50 to 100 have megapixel equivalents of 8 to 16 megapixels. ISO 400 films are only around 4 megapixels." This would place top-of-the-range digital cameras (as of 2006) well over 35 mm film cameras.

However, while 35 mm is the standard format for consumer cameras, many professional film cameras use Medium format or Large format films which, due to the size of the film used, can boast resolution many times greater than the current top-of-the-range digital cameras. For example, it is estimated that a medium format film photograph can record around 50 megapixels, while large format films can record around 200 megapixels (4 × 5 inch) [5] which would equate to around 800 megapixels on the largest common film format, 8 × 10 inches.

The resolution of modern black and white slow speed film, exposed through a high quality prime lens working at its optimum aperture yields usable detail at a scanned file size of greater than 30 megapixels. With consumer 35 mm color negative film an effective resolution of over 12 megapixels is achievable and in an inexpensive 35 mm point and shoot camera a resolution of over 8 megapixels may be achieved.

When deciding between film and digital and between different types of camera, it is necessary to take into account the medium which will be used for display. For instance, if

a photograph will only be viewed on a television or computer display (which can resolve only about 2 megapixels and 1.3 megapixels, respectively, as of 2006), then the resolution provided by a low-end digital cameras may be sufficient. For standard 4 × 6 inch prints, it is debatable whether there will be any perceived quality difference between digital and film. If the medium is a large billboard, then it is likely that the extra resolution of a medium or large format will be necessary. For larger prints, the extra resolution of a good 35 mm film photograph may be desirable.

It should be noted that a special case exists for long exposure photography - Currently available technology contributes random noise to the images taken by digital cameras, produced by thermal noise and manufacturing defects. Some digital cameras apply noise reduction to long exposure photographs to counteract this. For very long exposures it is necessary to operate the detector at low temperatures to avoid noise impacting the final image. Film grain is not affected by exposure time, although the apparent speed of the film does change with longer exposures.

Convenience and Flexibility

This has been one of the major drivers of the widespread adoption of digital cameras. Before the advent of digital cameras, once a photograph was taken, the roll of film would need to be finished and sent off to a lab to be developed. Only once the film was returned was it possible to see the photograph. However, most digital cameras incorporate an LCD screen which allows the photograph to be viewed immediately after it has been taken. This allows the photographer to delete unrequired photographs and offers an immediate opportunity to re-take. When a user desires prints, it is only necessary to print the good photographs.

Another major advantage of digital technology is that photographs can be conveniently moved to a personal computer for modification. Many digital cameras are capable of storing pictures in a RAW format which stores the output from the sensor directly rather than processing it immediately to an image. When combined with suitable software, such as dcraw, this allows the user to configure certain parameters of the taken photograph (such as sharpness or colour) before it is "developed" into a final image. More sophisticated users may choose to manipulate or alter the actual content of the recorded image.

Film photographs may be digitised in a process known as scanning. They may then be manipulated as digital photographs.

Price

The two formats (film and digital) have different emphases as regards pricing. With digital photography, cameras tend to be significantly more expensive than film ones, comparing like for like. This is offset by the fact that taking photographs is effectively cost-free. Photographs can be taken freely and copies distributed over the internet free of charge.

This should be contrasted with film photography where good-quality cameras tend to be less complicated and, therefore, less expensive. But this is at the expense of ongoing costs both in terms of film and processing costs. In particular, film cameras offer no chance to review photographs immediately after they are shot, and all photos taken must be processed before knowing anything about the quality of the final photograph.

There are costs associated with digital photography. Digital cameras use batteries, some of which are proprietary and quite expensive. While they are rechargable, they do degrade over time and must be periodically replaced. Although there is no film in digital cameras, there is the requirement to store the images on memory cards or microdrives which also have limited life. Additionally, some provision for storage of the digital image must be made. In general this would be either an optical disc produced by a shop or photofinisher, or by the photographer on a computer system. If physical prints are to be made they can either be purchased from a photofinisher, or produced by the photographer.

The price differential between the two formats is often dictated by the intent of the photographer and the purpose of his or her work.

Robustness

Film has advantages over digital, at least with current technology. One main advantages is latitude, or the ability to produce a good image from over- or underexposed negatives. Slightly overexposed digital images can lose all data in the highlights, and underexposed images will lose significant shadow detail. Photographers can over- or underexpose film, especially black and white film, and still produce normal images.

Dust on the image plane is a constant issue for photographers. Digital cameras are especially prone to dust problems because the sensor is static, and for digital SLRs dust is difficult to rectify. Some digital SLRs however, have rectification mechanisms which detect the dust particles on the image sensor and selectively ignore them to a certain degree. With film cameras, dust is easy to manage as film is replaced with each new image and good technique and clean handling methods reduce most problems.

Archiving

When choosing between film and digital formats, it is necessary to consider the suitability of each as an archival medium.

Films and prints processed and stored in ideal conditions have demonstrated an ability to remain substantially unchanged for more than 100 years. Gold or platinum toned prints probably have a lifespan limited only by the lifespan of the base material, probably many hundreds of years.

The archival potential of digital photographs is less well understood since digital media have existed for only the last 50 years. There exist three problems which must be overcome for archival usage: physical stability of the recording medium, future readability of the storage medium and future readability of the file formats used for storage.

Many digital media are not capable of storing data for prolonged periods of time. For example, magnetic disks and tapes may lose their data after twenty years, flash memory cards even less. Good quality optical media may be the most durable storage media for digital data.

It is important to consider the future readability of storage media. Assuming the storage media can continue to hold data for prolonged periods of time, the short lifespan of digital technologies often causes the drives to read media to become unavailable. For example, the first 5¼-inch Floppy disks were first made available in 1976. However, the drives to read them are already extremely rare just 30 years later.

It must also be considered whether there still exists software which can decode the data. For example, many modern digital cameras save photographs in JPEG format. This format has existed for only around 15 years. Whether it will still be readable in a century

is unknown, although the huge number of JPEG files currently being produced will surely influence this issue.

Most professional cameras can save in a RAW image format, the future of which is much more uncertain. Some of these formats contain proprietary data which is encrypted or protected by patents, and could be abandoned by their makers at any time for simple economic reasons. This could make it difficult to read these 'raw' files in the future, unless the camera makers were to release information on the file formats.

However, digital archives have several methods of overcoming such obstacles. In order to counteract the file format problems, many organizations prefer to choose an open and popular file format. Doing so increases the chance that software will exist to decode the file in the future.

Additionally many organisations take an active approach to archiving rather than relying on formats being readable decades later. This takes advantage of the ability to make perfect copies of digital media. So, for example, rather than leaving data on a format which may potentially become unreadable or unsupported, the information can typically be copied to newer media without loss of quality. This is only possible with digital media.

Integrity

Film produces a first generation image, which contains only the information admitted through the aperture of the camera. Film "sees" in color, in a specific spectral band such as Orthochromatic, or in broad Panchromatic sensitivity. Differences in Development technique can produce subtle changes in the finished Negative or Positive, but once this process is complete it is considered permanent.

Film images are very difficult to fabricate, thus in law enforcement and in cases where the authenticity of an image is important (Passport/Visa photographs), film provides greater security over digital, which has the disadvantage that photographs can be conveniently moved to a personal computer for modification.

hotography styles

Commercial photography

The commercial photographic world can be broken down to:

- Advertising photography: photographs made to illustrate a service or product. These images are generally done with an advertising agency, design firm or with an in-house corporate design team.
- Editorial photography: photographs made to illustrate a story or idea within the context of a magazine. These are usually assigned by the magazine.
- Photojournalism: this can be considered a subset of editorial photography. Photographs made in this context are accepted as a truthful documentation of a news story.
- Portrait and wedding photography: photographs made and sold directly to the end user of the images.
- Fine art photography: photographs made to fulfill a vision, and reproduced to be sold directly to the customer.

The market for photographic services demonstrates the aphorism "one picture is worth a thousand words," which has an interesting basis in the history of photography. Magazines and newspapers, companies putting up Web sites, advertising agencies and other groups pay for photography.

Many people take photographs for self-fulfillment or for commercial purposes. Organizations with a budget and a need for photography have several options: they can assign a member of the organization, hire someone, run a public competition, or obtain rights to stock photographs.

[edit] Photography as an art form

Manual shutter control and exposure settings can achieve unusual results

Classic Alfred Stieglitz photograph, *The Steerage* shows unique aesthetic of black and white photos.

During the twentieth century, both fine art photography and documentary photography became accepted by the English-speaking art world and the gallery system. In the United States, a small handful of curators spent their lives advocating to put photography in such a system, with Alfred Stieglitz, Edward Steichen, John Szarkowski, and Hugh Edwards the most prominent among them.

The aesthetics of photography is a matter that continues to be discussed regularly, especially in artistic circles. Many artists argued that photography was the mechanical reproduction of an image. If photography is authentically art, then photography in the context of art would need redefinition, such as determining what component of a photograph makes it beautiful to the viewer. The controversy began with the earliest images "written with light": Nicéphore Niépce, Louis Daguerre, and others among the very earliest photographers were met with acclaim, but some questioned if it met the definitions and purposes of art.

Clive Bell in his classic essay "Art" states that only one thing can distinguish art from what is not art: "significant form." Bell wrote:

> “ There must be some one quality without which a work of art cannot exist; possessing which, in the least degree, no work is altogether worthless. What is this quality? What quality is shared by all objects that provoke our aesthetic emotions? What quality is common to Sta. Sophia and the windows at Chartres, Mexican sculpture, a Persian bowl, Chinese carpets, Giotto's frescoes at Padua, and the

masterpieces of Poussin, Piero della Francesca, and Cezanne? Only one answer seems possible - significant form. In each, lines and colors combined in a particular way, certain forms and relations of forms, stir our aesthetic emotions.[6]

Camera

A **camera** is a device used to take pictures (usually photographs), either singly or in sequence, with or without sound recording, such as with video cameras. A camera that takes pictures singly is sometimes called a *photo camera* to distinguish it from a video camera. The name is derived from *camera obscura*, Latin for "dark chamber", an early mechanism for projecting images in which an entire room functioned much as the internal workings of a modern photographic camera, except there was no way at this time to record the image short of manually tracing it. Cameras may work with the visual spectrum or other portions of the electromagnetic spectrum.

Description

Every camera consists of some kind of enclosed chamber, with an opening or aperture at one end for light to enter, and a recording or viewing surface for capturing the light at the other end. Most cameras have a lens positioned in front of the camera's opening to gather the incoming light and to focus the image, or part of the image, on the recording surface. The diameter of the aperture is often controlled by a diaphragm mechanism, but some cameras have a fixed-size aperture.

The size of the aperture and the brightness of the scene control the amount of light that enters the camera during a period of time, and the shutter controls the length of time that the light hits the recording surface. For example, in lower light situations, the shutter

speed should be slower (longer time spent open) to allow the film to capture what little light is present.

Due to the optical properties of camera lenses, only objects within a certain range of distances from the camera will be reproduced clearly. The process of adjusting this range is known as changing the camera's focus. There are various ways of focusing a camera accurately. The simplest cameras have fixed focus and use a small aperture and wide-angle lens to ensure that everything within a certain range of distance from the lens (usually around 3 metres (10 feet) to infinity) is in reasonable focus. This is usually the kind found on one-use cameras and other cheap cameras. The camera can also have a limited focusing range or scale-focus that is indicated on the camera body. The user will guess or calculate the distance to the subject and adjust the focus accordingly. On some cameras this is indicated by symbols (head-and-shoulders; two people standing upright; one tree; mountains).

Rangefinder cameras allow the distance to objects to be measured by means of a coupled parallax unit on top of the camera, allowing the focus to be set accuracy. Single-lens reflex cameras allow the photographer to determine the focus and composition visually using the objective lens and a moving mirror to project the image onto a ground glass or plastic micro-prism screen. Twin-lens reflex cameras use an objective lens and a focusing lens unit (usually identical to the objective lens) in a parallel body for composition and focusing. View cameras use a ground glass screen which is removed and replaced by either a photographic plate or a reusable holder containing sheet film before exposure.

Many modern cameras offer systems to focus the camera automatically by a variety of methods .

Traditional cameras capture light onto photographic film or photographic plate. Video and digital cameras use electronics, usually a charge coupled device (CCD) or sometimes a CMOS sensor to capture images which can be transferred or stored in tape or computer memory inside the camera for later playback or processing.

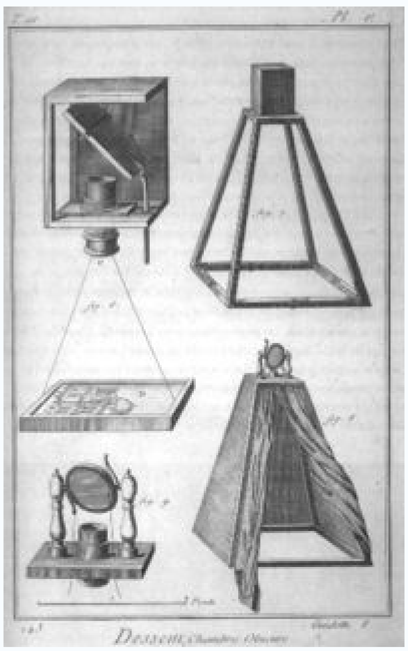
Cameras that capture many images in sequence are known as movie cameras or as ciné cameras in Europe; those designed for single images are still cameras. However these categories overlap, as still cameras are often used to capture moving images in special effects work and modern digital cameras are often able to trivially switch between still

and motion recording modes. A video camera is a category of movie camera which captures images electronically (either using analogue or digital technology).

Stereo camera can take photographs that appear "three-dimensional" by taking two different photographs which are combined to create the illusion of depth in the composite image. Stereo cameras for making 3D prints or slides have two lenses side by side. Stereo cameras for making lenticular prints have 3, 4, 5, or even more lenses.

Some film cameras feature date imprinting devices that can print a date on the negative itself.

History



Camera obscura

19th century studio camera, with bellows for focusing.

The first permanent photograph was made in 1826 by Joseph Nicéphore Niépce using a sliding wooden box camera made by Charles and Vincent Chevalier in Paris. Niépce built on a discovery by Johann Heinrich Schultz (1724): a silver and chalk mixture darkens under exposure to light. However, while this was the birth of photography, the camera itself can be traced back much further. Before the invention of photography, there was no way to preserve the images produced by these cameras apart from manually tracing them.

The first camera that was small and portable enough to be practical for photography was built by Johann Zahn in 1685, though it would be almost 150 years before technology caught up to the point where this was possible. Early photographic cameras were essentially similar to Zahn's model, though usually with the addition of sliding boxes for focusing. Before each exposure a sensitized plate would be inserted in front of the viewing screen to record the image. Jacques Daguerre's popular daguerreotype process utilized copper plates, while the calotype process invented by William Fox Talbot recorded images on paper.

The development of the collodion wet plate process by Frederick Scott Archer in 1850 cut exposure times dramatically, but required photographers to prepare and develop their glass plates on the spot, usually in a mobile darkroom. Despite their complexity, the wet-plate ambrotype and tintype processes were in widespread use in the latter half of the 19th century. Wet plate cameras were little different from previous designs, though there were some models (such as the sophisticated Dubroni of 1864) where the sensitizing and developing of the plates could be carried out inside the camera itself rather than in a separate darkroom. Other cameras were fitted with multiple lenses for making cartes de visite. It was during the wet plate era that the use of bellows for focusing became widespread.

Camera brands

- Agfa
- ARCA-Swiss
- Agilux
- Alpa
- Asahiflex
- Balda

Asahiflex

- Bolex
- Braun
- Bronica
- Burke & James
- Cambo
- Canon
- Casio
- Contax
- Corfield
- Coronet
- Ebony
- FED
- Folmer & Schwing
- Fujifilm
- Graflex
- Hasselblad
- Hewlett Packard
- Holga

Kodak Retina IIIc

- Horseman
- Ilford
- Imaging Solutions Group (ISG)
- Kodak
- Konica
- Leica
- Linhof
- Lomo
- Minolta
- Mamiya
- Minox

Nikon F of 1959

- MPP
- Mustek
- Newman & Guardia
- Nikon
- Olympus
- Osaka
- Panasonic
- Pentax
- Petri
- Polaroid
- Praktica
- Reid
- Ricoh
- Rollei

Voigtländer Vitoret of 1962

- Samsung
- Sigma Corporation
- Sony
- Thornton-Pickard
- Vivitar
- Voigtländer
- Wisner

- Wray
- Yashica
- Zeiss
- Zenit

Video camera

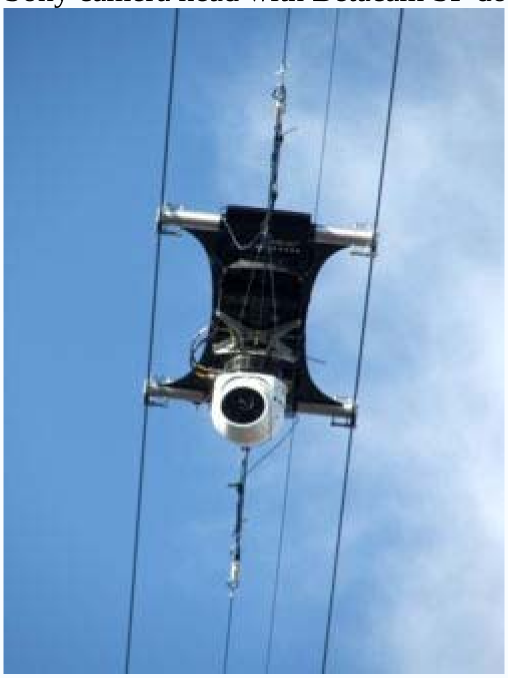
A **video camera** can be classified four ways:

- Professional video cameras, such as those used in television production; these may be studio-based or mobile
- Camcorders used by consumers and police; these are mobile
- Closed-circuit television cameras used for surveillance; these are not mounted on vehicles
- Special systems, like those used for scientic research, e.g. on board of a satellite or a spaceprobe

Professional video camera

Sony high definition studio television camera.

Sony camera head with Betacam SP dock recorder.



A remote-controlled camera mounted on a miniature cable car for mobility.

A **Professional video camera** (often called a **Television camera** even though the use has spread) is a high-end device for recording electronic moving images (as opposed to a movie camera, that records the images on film). Originally developed for use in television studios, they are now commonly used for corporate and educational videos, music videos, direct-to-video movies, etc. Less advanced video cameras used by consumers are often referred to as camcorders.

There are two types of professional video cameras: High end portable, recording cameras (which are, confusingly, called camcorders too) used for ENG image acquisition, and studio cameras which lack the recording capability of a camcorder, and are often fixed on studio pedestals.

Technology

It is common for professional cameras to split the incoming light into the three primary colors that humans are able to see, feeding each color into a separate pickup tube (in older cameras) or charge-coupled device (CCD). Some high-end consumer cameras also do this, producing a higher-quality image than is normally possible with just a single video pickup.

Studio cameras

Most studio cameras stand on the floor, usually with pneumatic or hydraulic mechanisms to adjust the height, and are usually on wheels. Any video camera when used along with other video cameras in a studio setup is controlled by a device known as CCU (camera control unit), to which they are connected via a Triax or Multicore cable. The camera control unit along with other equipments is installed in the production control room often known as Gallery of the television studio. When used outside a studio, they are often on tracks. Initial models used analog technology, but digital models are becoming more common. Some studio cameras are light and small enough to be taken off the pedestal and used on a cameraman's shoulder, but they still have no recorder of their own and are cable-bound.

ENG cameras

ENG video cameras are similar to consumer camcorders, and indeed the dividing line between them is somewhat blurry, but a few differences are generally notable:

- They are bigger, and usually have a shoulder stock for stabilizing on the cameraman's shoulder
- They use 3 CCDs
- They have removable/swappable lenses
- All settings like white balance, focus and iris can be manually adjusted, and automatics can be completely disabled
- If possible, these functions will be even adjustable mechanically (especially focus and iris), not by passing signals to an actuator or digitally dampening the video signal.
- They will have professional connectors - BNC for video and XLR for audio
- A complete timecode section will be available, and multiple cameras can be timecode-synchronized with a cable
- "Bars and tone" will be available in-camera (the bars are SMPTE (Society of Motion Picture and Television Engineers) Bars similar to those seen on television when a station goes off the air, the tone is a test audio tone)

- Finally, they will use a professional medium like some variant of Betacam or DVCPRO, though some professional DV cameras are available, Canon's XL1/XL2 and Sony's VX2100 cameras being examples. The XL1/2 and Sony VX2100 and cameras similar to them are not considered professional cameras, but fall into the "pro-sumer" line.

Dock cameras

Some manufacturers build *camera heads*, which only contain the optical array, the CCD sensors and the video coder, and can be used with a *studio adaptor* for connection to a CCU or various *dock recorders* for direct recording in the preferred format, making them very versatile. However, this versatility leads to greater size and weight, and dock cameras have become rare in recent years. They are, however, still favored for electronic field production and low-budget studio use, because they tend to be smaller, lighter, and less expensive than most studio cameras.

Camcorder

Before the camcorder. This separate portable Betamax recorder and camera arrangement slightly predates the first camcorders

The Betamovie, the first domestic camcorder, 1983

8 mm Camcorder

Sony DV Handycam

MICROMV camcorder and tape (top) compared to miniDV and Hi8 tapes

A **camcorder** is a portable electronic device (generally a digital camera) for recording video images and audio onto a storage device. The camcorder contains both *cam*era and re*corder* in one unit, hence its portmanteau name. This compares to previous technology where they would be separate.

History

Video cameras were originally designed for broadcasting television images — see television camera. Cameras found in television broadcast centres were extremely large, mounted on special trolleys, and wired to remote recorders located in separate rooms. As technology advanced, miniaturization eventually enabled the construction of portable video-cameras and portable video-recorders.

Prior to the introduction of the camcorder, portable video-recording required two separate devices: a video-camera and a VCR. Specialized models of both the camera and VCR were used for mobile work. The portable VCR consisted of the cassette player/recorder unit, and a television tuner unit. The cassette unit could be detached and carried with the user for video recording. While the camera itself could be quite compact, the fact that a separate VCR had to be carried generally made on-location shooting a two-person job.

In 1982, Sony released the first professional camcorder named "BETACAM". BETACAM was developed as a standard for professional camcorders. At first, cameramen didn't welcome BETACAM, because before BETACAM, carrying and

operating the VCR unit was a work of a video engineer, after BETACAM, they came to be required to operate both video camera and VCR. However, the cable between cameramen and video engineers was eliminated. For this reason, the freedom of cameramen has improved dramatically and BETACAM became standard.

In 1983, Sony released Betamovie for consumers, the first domestic camcorder. A novel technique was used to reduce the size of the spinning video head drum, which was then used for many subsequent camcorders. The unit was bulky by today's standards, and since it could not be held in one hand, was typically used on resting on a shoulder. Some later camcorders were even larger, because the Betamovie models had only optical viewfinders and no playback or rewind capability. Most camcorders were and still are designed for right-handed operation, though a few possessed ambidextrous ergonomics.

Within a few years, manufacturers introduced two new tape formats tailored to the application of portable-video: the VHS-C format and the competing 8mm. VHS-C was essentially VHS with a reduced-size cassette. The VHS-C cassette held enough tape to record 30 minutes of VHS video, while a mechanical adapter enabled playback of VHS-C videocassettes in standard (full-size) VHS VCRs. VHS-C allowed manufacturers to reduce the weight and size of VHS-derived camcorders, although at the expense of recording time. The alternative 8 mm video on the other hand radically reduced the size of camcorders without the problem of short running time, by using an all-new metal composition video cassette. 8 mm video used a tape whose width is 33% less than VHS/Betamax tape (~12.7 mm), allowing even further miniaturization in the recorder's tape-transport assembly and cassette media.

8mm video represented a trade-off for the consumer. On the plus side, the 8mm camcorder generally produced higher quality recordings than a VHS/VHS-C camcorder, and the standard 8mm cassette could record up to two hours. On the down side, since the 8mm format was incompatible with VHS, 8mm recordings could not be played in VHS VCRs. In most cases, viewers would connect the camcorder to their home VCR, and copy their recordings on to a VHS tape.

The dominance of VHS among TV-timeshifters and rental-audiences guaranteed VHS-C an uneasy coexistence alongside 8mm. Serious amateur-videographers preferred 8mm, simply because it was better suited (than VHS/VHS-C) for the task of video production. But some casual and family users preferred VHS-C because of its shared lineage (and

familiarity) with VHS. Equally important, entry-level VHS-C camcorders were priced less than 8 mm units. During the 1990s, the UK market saw Video8 and Hi8 eat into VHS-C/S-VHS-C sales as manufacturers such as Sharp Corporation dropped their VHS-C models in favour of 8mm. Eventually the only major manufacturers marketing VHS-C were JVC and Panasonic, so the format fell into obsolescence.

Throughout the 1990s, camcorder sales had the unintended side-effect of hurting the *still camera photography* market. Among the mass consumer market, camcorders gradually replaced still cameras for vacation and travel use. All Camcorders had a built in microphone, even though in the 1990s the use of a uni-directional microphone provided a more professional sound quality. Most analog-format camcorders traditionally had a single microphone, providing monophonic sound; it was only with the rise of digital camcorders that stereo microphones became common, and some DVD-based camcorders even include surround sound capability.

In the late 1990s, the camcorder reached the digital era with the introduction of miniDV. Its cassette media was even smaller than 8 mm media, allowing another size reduction of the tape transport assembly. The digital nature of miniDV also improved audio and video quality over the best of the analog consumer camcorders (SVHS-C, Hi8.) Variations on the digital-video camcorder included the Digital8 camcorder, and the DVD camcorder.

The evolution of the camcorder has seen the growth of the camcorder market as price reductions and size reductions make the technology more accessible to a wider audience. When camcorders were first introduced, they were bulky shoulder-operated luggables that cost over $1,500 US dollars. As of 2006, an entry-level MiniDV camcorder fits in the palm of a person's hand, at a price under $300 US dollars.

Overview

Major components

Camcorders contain 3 major components: **lens**, **imager**, and **recorder**. The lens gathers and focuses light on the imager. The imager (usually a CCD or CMOS sensor on modern camcorders; earlier examples often used vidicon tubes) converts incident light into an electrical (video) signal. Finally, the recorder encodes the video signal into a storable form. More commonly, the optics and imager are referred to as the *camera* section.

The **lens** is the first component in the camera-section's "light-path". The camcorder's optics generally have one or more of the following adjustments: aperture (to control the amount of light), zoom (to control the field-of-view), and shutter speed (to capture continuous motion.) In consumer units, these adjustments are automatically controlled by the camcorder's electronics, generally to maintain constant *exposure* onto the imager. Professional units offer direct user control of all major optical functions (aperture, shutter-speed, focus, etc.)

The **imager** section is the *eye* of the camcorder, housing a photosensitive device(s). The imager converts light into an electronic video-signal through an elaborate electronic process. The camera lens projects an image onto the imager surface, exposing the photosensitive array to light. The light exposure is converted into electrical charge. At the end of the timed exposure, the imager converts the accumulated charge into a continuous analog voltage at the imager's output terminals. After scan-out is complete, the photosites are reset to start the exposure-process for the next video frame. In modern (digital) camcorders, an analog-to-digital (ADC) converter digitizes the imager (analog) waveform output into a discrete digital-video signal.

The third section, the **recorder**, is responsible for writing the video-signal onto a recording medium (such as magnetic videotape.) The record function involves many signal-processing steps, and historically, the recording-process introduced some distortion and noise into the stored video, such that playback of the stored-signal may not retain the same characteristics/detail as the live video feed.

All but the most primitive camcorders imaginable also need to have a recorder-controlling section which allows the user to control the camcorder, switch the recorder into playback mode for reviewing the recorded footage and an image control section which controls exposure, focus and white-balance.

The image recorded need not be limited to what appeared in the viewfinder. For documentation of events, such as used by police, the field of view overlays such things as the time and date of the recording along the top and bottom of the image. Such things as the police car or constable to which the recorder has been allotted may also appear; also the speed of the car at the time of recording. Compass direction at time of recording and geographical coordinates may also be possible. These are not kept to world-standard fields; "month/day/year" may be seen, as well as "day/month/year", besides the ISO

standard "year-month-day". And the Danish police have the speed of the police car in the units "Km/t" *sic* (*time* being Danish for "hour").

Consumer camcorders

Analog vs. digital

Camcorders are often classified by their storage device: VHS, Betamax, Video8 are examples of older, videotape-based camcorders which record video in analog form. Newer camcorders include Digital8, miniDV, DVD, Hard drive and solid-state (flash) semiconductor memory, which all record video in digital form. (Please see the video page for details.) The imager-chip is considered an analog component, so the *digital* namesake is in reference to the camcorder's processing and recording of the video.

Digital has the advantage over analog of suffering very little generation loss in recording, dubbing, and editing. Whereas noise and bandwidth issues relating to cables, amplifiers, and mixers greatly affect analog recordings such problems are minimal or non-existent in digital formats. Both analog and digital can suffer from archival problems. Theoretically digital information can be stored indefinitely with zero deterioration on a digital storage device (such as a hard drive), but other types of media can have problems. Both analog and digital tape formats are prone deterioration over time. And digital recordings on DVD are known to suffer from DVD rot. The one advantage analog seems to have in this respect is that an analog recording may be "usable" even after the media it is stored on has suffered severe deterioration whereas it has been noticed[1] that even slight media degradation in digital recordings may cause them to suffer from an "all or nothing" failure, i.e. the digital recording will end up being totally un-playable without very expensive restoration work.

Modern recording media

Some recent camcorders record video on flash memory devices (in MPEG-1, MPEG-2 or MPEG-4), Microdrives, small hard disks or size-reduced DVD-RAM or DVD-Rs in MPEG-2 format - but due to the limited size of the recording medium, their uninterrupted recording time is limited.

All other digital consumer camcorders record in DV format on tape and transfer its content over FireWire (some also use USB 2.0) to a computer, where the huge files (1GB

for 4 to 4.6 minutes in PAL/NTSC resolutions) can be edited, converted, (and with many camcorders) also played back to tape. The transfer is done at normal speed, so the complete transfer of a 60 minute tape needs one hour to transfer and about 14GB disk space for the raw footage only - excluding any space needed for render files, and other media. Time in post-production (editing) to select and cut the best shots varies from instantaneous "magic" movies to hours of tedious selection.

Consumer Market

As the mainstream consumer market favors ease of use, portability, and price, consumer camcorders emphasize these features more than raw technical performance. For example, good low-light capabilities require large capturing chips, which affects price and size. Thus, consumer camorders are unable to shoot useful footage in dim light. Manual controls need space, either in menus or as buttons and make the use more complicated, which goes against the requirement of ease of use. Consumer units offer a plethora of I/O options (IEEE 1394/Firewire, USB 2.0, Composite and S-Video), but lack many manual settings, often excluding video exposure, gain control, or sound level management. For the beginner, entry-level camcorders offer basic recording and playback capability.

For the sophisticated hobbyist (prosumer), high-end units offer improved optical and video performance through multi-CCD components and name-brand optics, manual control of camera exposure, and more, but even consumer camcorders which are sold for $1000 such as the Panasonic GS250 are not well-suited for recording in dim light. When dimly-lit areas are brightened in-camera or in post-production, considerable noise distracts the viewer.

Before the 21st century, consumer video editing was a difficult task requiring a minimum of two recorders. Now, however, a contemporary Personal Computer of even modest power can perform digital video editing with low-cost editing software. Many consumer camcorders bundle a *light version* of such software (with limited features.)

As of 2006, analog camcorders are still available but not widely marketed anymore; those that are still available are often less than US$250, but require special capture hardware for non-linear editing. In terms of sales, Digital8 and especially miniDV recorders dominate most first world markets. Camcorders which record directly on DVD media are also on the rise.

Hard disk based camcorders are appearing as well. They allow for recording directly to a large internal hard drive. JVC has several models out. While Sony has released one so far, more will be released in the coming months, including an HD model. Increased storage capacity over other types of media is the main advantage with these models. But with this follows a sligthly reduced image quality when compared to other formats such as MiniDV, making the ease of transferring the footage to a PC for quick editing the main attraction of Hard disk camcorders.

Other devices with Video-capture capability

Video-capture capability is now available in selected models of cellphones, digicams, and other portable consumer electronic devices such as media players. Typically only digital cameras offer videos that are of useful quality for anything other than a novelty. The marketing approach is to claim 320 X 240 video is "VHS quality," and 640 X 480 video is "DVD quality." A few cameras can offer 800 X 600 resolution, and a recent development is High Definition (720p) in cameras such as the Sanyo Xacti HD1.

All are limited somewhat by having to serve as both cameras and camcorders. Compared to a dedicated camcorder they have poor low light performance, limited options, and many do not offer zoom during filming. (This is because the noise from the zooming motor is heard on the clip, only a few digicams have a manual zoom.) Many either have fixed focus lenses, or autofocus lenses that are sluggish and noisy compared to a camcorder.

The quality varies widely depending on the compression format used and the type of device. Frame rates can range from 30 FPS down to 10 FPS, or can be variable, slowing down in dark settings. The length of clips can also vary from "unlimited" (up to the capacity of the storage media) down to a few minutes.

Low end MPEG-4 "camcorders" can often record unlimited length video clips at 320 X 240, but the quality is far below even a VHS-C camcorder. In addition, MPEG-4 is currently not widely supported in many video editing programs. Cameras recording in Quicktime format produce videos of acceptable quality, but the compression appears as a grain or static in the video. Some cameras can offer exceptionally good video quality using the MJPEG codec, but the files are so large the recording time at high quality with a 1GB card is under ten minutes.

The use of digicams for recording video clips is limited mainly to circumstances where quality is not an issue. This is gradually being offset by the greater sophistication of the cameras, the increasing storage capacity of flash cards and microdrives, and the desire of consumers to carry only a single device.

Uses

Media

Camcorders have found use in nearly all corners of electronic media, from electronic news organizations to TV/current-affairs productions. In locations away from a distribution infrastructure, camcorders are invaluable for initial video acquisition. Subsequently, the video is transmitted electronically to a studio/production center for broadcast. Scheduled events such as official press conferences, where a video infrastructure is readily available or can be feasibly deployed in advance, are still covered by studio-type video cameras (tethered to "production trucks.")

An elderly person filming the San Francisco bay from Coit tower using a JVC recorder

Home Video

For casual use, camcorders often cover weddings, birthdays, graduation ceremonies, and other personal events. The rise of the consumer camcorder in the mid to late '80s led to the creation of shows such as the long-running America's Funniest Home Videos, where people could showcase homemade video footage.

Politics

Political protestors have capitalized on the value of media coverage use camcorders to film things they believe to be unjust. Animal rights protestors who break into factory farms and animal testing labs use camcorders to film the conditions the animals are living in. Anti-hunting protestors film fox hunts. Anti-globalization protestors film the police to

deter police brutality. If the police do use violence there will be evidence on video. Greenpeace uses camcorders to film their activities. Activist videos often appear on Indymedia.

The police use camcorders to film riots, protests and the crowds at sporting events. The film can be used to spot and pick out troublemakers, who can then be prosecuted in court.

Entertainment and movies

Camcorders are often used in the production of low-budget TV shows and the works of garage movie studios, where the production crew does not have access to more professional equipment. There are even examples of Hollywood movies shot entirely on consumer camcorder equipment (see *Blair Witch Project* and *28 Days Later*). In addition, many academic filmmaking programs have switched from 16mm film to digital video, due to the vastly reduced expense and ease of editing of the digital medium as well as the increasing scarcity of film stock and equipment.

Voyeurism

Camcorders can be used for voyeurism. In one of the most famous examples, Japanese television performer Masashi Tashiro was caught for taking a sneak shot of a woman's skirt (known as upskirt), in a commuter train station. When reporters asked why he had done it, he explained, "I tried to make a gag called "**An octopus appears in a miniskirt**" (Mini ni Tako ga Dekiru,)". [2]

Formats

The following list covers consumer equipment only. (For other formats see Videotape)

Analog

- VHS: compatible with standard VCRs, though full-sized VHS camcorders are no longer made. Largely obsolete as a production medium.
- VHS-C: Designed for compact consumer camcorders; identical in quality to VHS.
- S-VHS: Largely used in high-end consumer and professional equipment; rare among mainstream consumer equipment, and obsoleted by digital gear.
- S-VHS-C: Designed for consumer equipment; currently available only on ultra-low-end equipment.

- Betamax: Only used on very old Sony camcorders; obsolete by the mid-80s in the consumer market although it continues to be used by professionals in the form of Betacam.
- Video8: small-format tape developed by Sony; equivalent to or slightly better than VHS, but not compatible. Obsolete.
- Hi8: Enhanced-quality Video8; originally used for professional field production, but now limited to ultra-low-end consumer market.

Digital

Digital Tapeless: Low-end digital tapeless systems often use an MPEG-4 codec and flash memory; high-end versions, on the other hand, store video data to hard disk or optical disc.
DV codec based:

- MiniDV and several derivatives, including DVCPRO from Panasonic and DVCAM from Sony. DV records the highest quality pictures (generally agreed to be at or near broadcast-quality) on DV tapes that are easily transferable via Firewire or USB to personal computers. Though designed as a consumer standard, there is extensive use of MiniDV in low-budget film and television production.
- Digital8, that uses Hi8 tapes (Sony is the only company currently producing D8 camcorders, though Hitachi used to). Some models of Digital 8 cameras have the ability to read older Hi8 analog format tapes. Though theoretically capable of the same quality as MiniDV, in practice most Digital8 equipment has been mid- to low-end consumer equipment, with virtually no demand in professional settings.

MPEG-2 codec based:

- MICROMV: Uses a matchbox-sized cassette. Sony was the only electronics manufacturer for this format, and editing software was proprietary to Sony and only available on Microsoft Windows. No longer in production.
- DVD (with the biggest market increases): Mini DVD-R and DVD-RAM. This is a multi-manufacturer standard that uses 8 cm DVD discs for 30 minutes of video. DVD-R can be played on consumer DVD players but cannot be added to or recorded over once finalized for viewing. DVD-RAM can be added to and/or recorded over, but cannot be played on many consumer DVD players. The DVD-RW is another option allowing the user to re-record, but costs much more per disc. DVD camcorders are generally not designed to connect to computers for editing purposes, though some high-end DVD units do record surround sound, a feature not standard with DV equipment.
- HDV: Records up to an hour of HDTV MPEG-2 signal roughly equal to broadcast quality HD on a standard MiniDV cassette.

Digital camcorders and Operating Systems

Since most manufacturers focus their support on Windows and Mac users, users of other operating systems often are unable to receive support for these devices. However, open source products such as Cinelerra and Kino (written for the Linux operating system) do allow full editing of some digital formats on alternative operating systems, and software to edit DV streams in particular is available on most platforms.

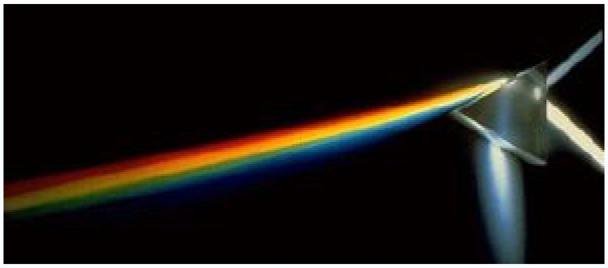
Many low-end tapeless camcorders, however, do not support any operating system but Windows, requiring either third-party software or a switch to a more standardized format such as DV.

Visible spectrum

The **visible spectrum** (or sometimes **optical spectrum**) is the portion of the electromagnetic spectrum that is visible to the human eye. Electromagnetic radiation in this range of wavelengths is called **visible light** or simply light. There are no exact bounds to the visible spectrum; a typical human eye will respond to wavelengths from 400 to 700 nm, although some people may be able to perceive wavelengths from 380 to 780 nm. A light-adapted eye typically has its maximum sensitivity at around 555 nm, in the green region of the optical spectrum (see: luminosity function). The spectrum does not, however, contain all the colors that the human eyes and brain can distinguish. Brown, pink, and magenta are absent, for example. See Color to understand why.

Wavelengths visible to the eye also pass through the "optical window", the region of the electromagnetic spectrum which passes largely unattenuated through the Earth's atmosphere (although blue light is scattered more than red light, which is the reason the sky is blue). The response of the human eye is defined by subjective testing (see CIE), but the atmospheric windows are defined by physical measurement. The "visible window" is so called because it overlaps the human visible response spectrum; the near infrared (NIR) windows lie just out of human response window, and the Medium Wavelength IR (MWIR) and Long Wavelength or Far Infrared (LWIR or FIR) are far beyond the human response region.

The eyes of many species perceive wavelengths different from the spectrum visible to the human eye. For example, many insects, such as bees, can see light in the ultraviolet, which is useful for finding nectar in flowers. For this reason, plant species whose life cycles are linked to insect pollination may owe their reproductive success to their appearance in ultraviolet light, rather than how colorful they appear to our eyes.

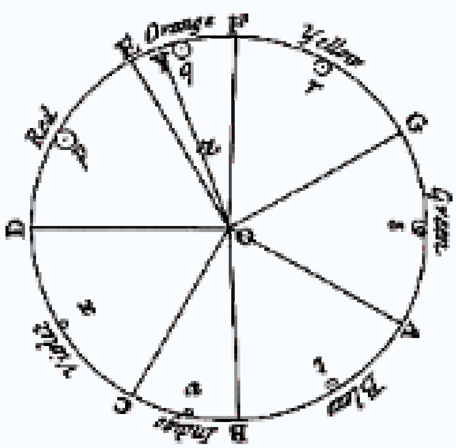


White light dispersed by a prism into the colors of the optical spectrum.

Historical use of the term

Two of the earliest explanations of the optical spectrum came from Isaac Newton, when he wrote his *Opticks*, and from Goethe, in his *Theory of Colours*.

Newton first used the word *spectrum* (Latin for "appearance" or "apparition") in print in 1671 in describing his experiments in optics. Newton observed that, when a narrow beam of white sunlight strikes the face of a glass prism at an angle, some is reflected and some of the beam passes into and through the glass, emerging as different colored bands. Newton hypothesized that light was made up of "corpuscles" (particles) of different colors, and that the different colors of light moved at different speeds in transparent matter, with red light moving more quickly in glass than violet light. The result is that red light was bent (refracted) less sharply than violet light as it passed through the prism, creating a spectrum of colors.



Newton's color circle, showing the colors correlated with musical notes and symbols for the planets.

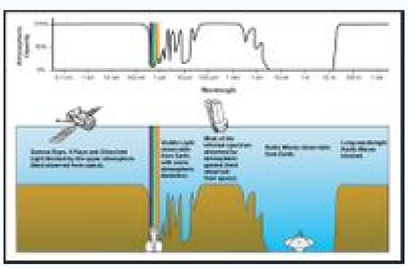
Newton divided the spectrum into seven named colors: Red, Orange, Yellow, Green, Blue, Indigo, and Violet; or ROYGBIV. He chose seven colors out of a belief, derived from the ancient Greek philosophers, that there was a connection between the colors, the

musical notes, the known objects in the solar system, and the days of the week.[1][2] The human eye is relatively insensitive to indigo's frequencies, and some otherwise well-sighted people cannot distinguish indigo from blue and violet. For this reason some commentators including Isaac Asimov have suggested that indigo should not be regarded as a color in its own right but merely as a shade of blue or violet.

Johann Wolfgang von Goethe contended that the continuous spectrum was a compound phenomenon. Whereas Newton narrowed the beam of light in order to isolate the phenomenon, Goethe observed that with a wider aperture, there was no spectrum - rather there were reddish-yellow edges and blue-cyan edges with white between them, and the spectrum only arose when these edges came close enough to overlap.

It is now generally accepted that light is composed of photons (which display some of the properties of a wave and some of the properties of a particle; see Wave-particle duality), and that all light travels at the same speed (the speed of light) in a vacuum. The speed of light within a material is lower than the speed of light in a vacuum, and the ratio of speeds is known as the refractive index of the material. In some materials, known as non-dispersive, the speed of different frequencies (corresponding to the different colors) does not vary, and so the refractive index is a constant. However, in other (dispersive) materials, the refractive index (and thus the speed) depends on frequency in accordance with a dispersion relation: glass is one such material, which enables glass prisms to create an optical spectrum from white light.

Spectroscopy



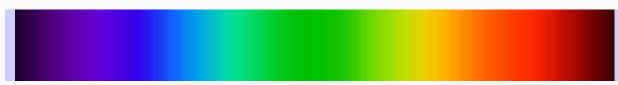
Rough plot of Earth's atmospheric transmittance (or opacity) to various wavelengths of electromagnetic radiation, including visible light.

The scientific study of objects based on the spectrum of the light they emit is called spectroscopy. One particularly important application of spectroscopy is in astronomy, where spectroscopy is essential for analysing the properties of distant objects. Typically,

astronomical spectroscopy utilises high-dispersion diffraction gratings to observe spectra at very high spectral resolutions. Helium was first detected through an analysis of the spectrum of the Sun; chemical elements can be detected in astronomical objects by emission lines and absorption lines; the shifting of spectral lines can be used to measure the redshift or blueshift of distant or fast-moving objects. The first exoplanets to be discovered were found by analysing the doppler shift of stars at such a high resolution that variations in their radial velocity as small as a few metres per second could be detected: the presence of planets was revealed by their gravitational influence on the stars analysed, as revealed by their motion paths.

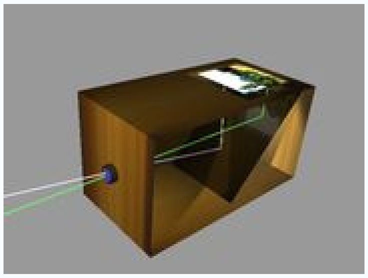
Spectral colors

Although the spectrum is continuous and therefore there are no clear boundaries between one color and the next, the following table gives approximate boundaries for the spectral colors:[3]



violet	380–450 nm
blue	450–495 nm
green	495–570 nm
yellow	570–590 nm
orange	590–620 nm
red	620–750 nm

Camera obscura



The **camera obscura** (Lat. *dark chamber*) was an optical device used in drawing, and one of the ancestral threads leading to the invention of photography. Photographic devices today are still known as "cameras".

The principle of the camera obscura can be demonstrated with a rudimentary type, just a box (which may be room-size) with a hole in one side, (see pinhole camera for construction details). Light from only one part of a scene will pass through the hole and strike a specific part of the back wall. The projection is made on paper on which an artist can then copy the image. The advantage of this technique is that the perspective is right, thus greatly increasing the realism of the image (correct perspective in drawing can also be achieved by looking through a wire mesh and copying the view onto a canvas with a corresponding grid on it).

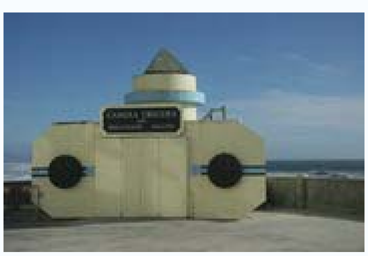
With this simple do-it-yourself apparatus, the image is always upside-down. By using mirrors, as in the 18th century overhead version illustrated, it is also possible to project a right-side-up image. Another more portable type, as in the second drawing, is a box with an angled mirror projecting onto tracing paper placed on the glass top, the image upright as viewed from the back.

As a pinhole is made smaller, the image gets sharper, but the light-sensitivity decreases. With too small a pinhole the sharpness again becomes worse due to diffraction. Practical camerae obscurae use a lens rather than a pinhole because it allows a larger aperture, giving a usable brightness while maintaining focus.

A freestanding room-sized camera obscura used by the art department at the University of North Carolina at Chapel Hill. One of the pinholes can be seen in the panel to the left of the door.

Some camerae obscurae have been built as tourist attractions, often taking the form of a large chamber within a high building that can be darkened so that a 'live' panorama of the world outside is projected onto a horizontal surface through a rotating lens. Although few now survive, examples can be found in Grahamstown in South Africa, Bristol, Portslade village and Eastbourne Pier in England, Aberystwyth and Portmeirion in Wales, Kirriemuir, Dumfries and Edinburgh in Scotland, Lisbon in Portugal, and Santa Monica and San Francisco in California, Havana in Cuba, Eger in Hungary, and Cádiz in Spain [1]There is even a portable example which Willett & Patteson tour around England and the world.

The principles of the camera obscura have been known since antiquity. It has been claimed that Ibn al-Haitham built a working camera obscura in the 10th century. Its potential as a drawing aid may have been familiar to artists by as early as the 15th century; Leonardo da Vinci described camera obscura in *Codex Atlanticus*. Johann Zahn's *Oculus Artificialis Teledioptricus Sive Telescopium* was published in 1685. This work contains many descriptions and diagrams, illustrations and sketches of both the camera obscura and of the magic lantern.

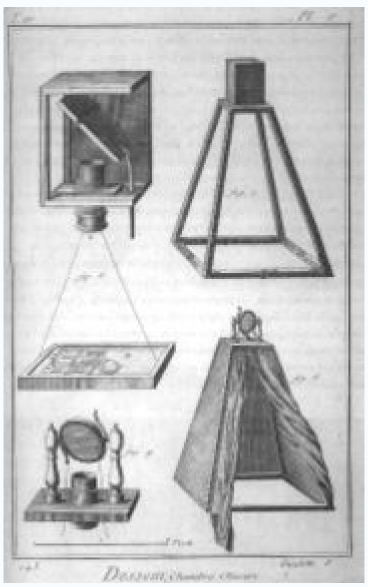

A freestanding room-sized camera obscura in the shape of a camera located in San Francisco at the Cliff House in Ocean Beach (San Francisco)

The Dutch Masters, such as Johannes Vermeer, who were hired as painters in the 17th Century, were known for their magnificent attention to detail. It has been widely

speculated that they made use of such a camera, but the extent of their use by artists at this period remains a matter of considerable controversy.

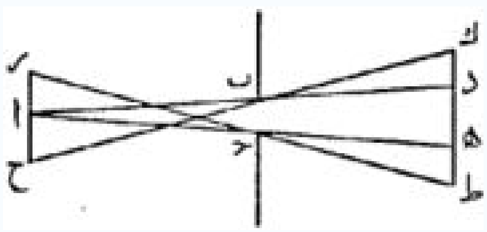
Early models were large; comprising either a whole darkened room or a tent (as employed by Johannes Kepler). By the 18th century, following developments by Robert Boyle and Robert Hooke, more easily portable models became available. These were extensively used by amateur artists while on their travels, but they were also employed by professionals, including Paul Sandby, Canaletto and Joshua Reynolds, whose camera (disguised as a book) is now in the Science Museum (London). Such cameras were later adapted by Louis Daguerre and William Fox Talbot for creating the first photographs.

The Discovery and Origins of the Camera Obscura



It has been established that the discovery of the camera obscura was accidental, sometime in early 11th century Egypt. A Muslim named Abu Ali Al-Hasan Ibn al-Haitham (965-1039 CE), known in the West as Al-Hazen, is accredited for its discovery while carrying out practical experiments on optics. In his various experiments, Ibn Al-Haitham used the term “*Al-Bayt al-Muthlimah*”, translated in English as dark room. For example, in the experiment he undertook in order to establish that light travels in time and with speed; he says: “If *the hole was covered with a curtain and the curtain was taken off, the light traveling from the hole to the opposite wall will consume time.”* He reiterated the same experience when he established that light travels in straight lines. The most revealing experiment which indeed introduced the camera obscura was in his studies of the half-moon shape of the sun’s image during eclipses which he observed on the wall opposite a small hole made in the window shutters. He commented on his observation "The *image of the sun at the time of the eclipse, unless it is total, demonstrates that when its light passes through a narrow, round hole and is cast on a plane opposite to the hole it takes on the form of a moon-sickle*”.

In his experiment of the sun light he extended his observation of the penetration of light through the pinhole to conclude that when the sun light reaches and penetrates the hole it makes a conic shape at the points meeting at the pinhole, forming later another conic shape reverse to the first one on the opposite wall in the dark room. This happens when sun light diverges from point “ا” until it reaches an aperture “حب” and is projected through it onto a screen at the luminous spot “هد”. Since the distance between the aperture and the screen is insignificant in comparison to the distance between the aperture and the sun, the divergence of sunlight after going through the aperture should be insignificant. In other words, “حب” should be about equal to “هد”. However, it is observed to be much greater “طك” when the paths of the rays which form the extremities of “طك” are retraced in the reverse direction, it is found that they meet at a point outside the aperture and then diverge again toward the sun as illustrated in figure 1. This was indeed the first accurate description of the Camera Obscura phenomenon.



In camera terms, the light converges into the room through the hole transmitting with it the object(s) facing it. The object will appear in full colour but upside down on the projecting screen/wall opposite the hole inside the dark room, also known in Arabic as “qamara”, hence Latin camera. The explanation is that light travels in a straight line and when some of the rays reflected from a bright subject pass through the small hole in thin material they do not scatter but cross and reform as an upside down image on a flat white surface held parallel to the hole. Ib Al-Haitham established that the smaller is the hole the clearer is the picture.

Electromagnetic spectrum

FREQUENCY	WAVELENGTH	ENERGY
300 EHz	1 pm	1.24 MeV
30 EHz	10 pm	124 keV
3 EHz	100 pm	12.4 keV
300 PHz	1 nm	1.24 keV
30 PHz	10 nm	124 eV
3 PHz	100 nm	12.4 eV
300 THz	1 μm	1.24 eV
30 THz	10 μm	124 meV
3 THz	100 μm	12.4 meV
300 GHz	1 mm	1.24 meV
30 GHz	1 cm	124 μeV
3 GHz	1 dm	12.4 μeV
300 MHz	1 m	1.24 μeV
30 MHz	1 dam	124 neV
3 MHz	1 hm	12.4 neV
300 kHz	1 km	1.24 neV
30 kHz	10 km	124 peV
3 kHz	100 km	12.4 peV
300 Hz	1 Mm	1.24 peV
30 Hz	10 Mm	124 feV

Legend:
γ = Gamma rays
HX = Hard X-rays
SX = Soft X-Rays
EUV = Extreme ultraviolet
NUV = Near ultraviolet
Visible light
NIR = Near infrared
MIR = Moderate infrared
FIR = Far infrared

Radio waves:
EHF = Extremely high frequency (Microwaves)
SHF = Super high frequency (Microwaves)
UHF = Ultrahigh frequency
VHF = Very high frequency
HF = High frequency
MF = Medium frequency
LF = Low frequency
VLF = Very low frequency

VF = Voice frequency
ELF = Extremely low frequency

The **electromagnetic spectrum** is the range of all possible electromagnetic radiation. Also, the "electromagnetic spectrum" (usually just *spectrum*) of an object is the range of electromagnetic radiation that it emits, reflects, or transmits. The electromagnetic spectrum, shown in the chart, extends from just below the frequencies used for modern radio (at the long-wavelength end) to gamma radiation (at the short-wavelength end), covering wavelengths from thousands of kilometres down to fractions of the size of an atom. It is commonly said that EM waves beyond these limits are uncommon, although this is not actually true. The 22-year sunspot cycle, for instance, produces radiation with a period of 22 years, or a frequency of $1.4*10^{-9}$ Hz. At the other extreme, photons of arbitrarily high frequency may be produced by colliding electrons with positrons at appropriate energy. 10^{24} Hz photons can be produced today with man-made accelerators. In our universe the short wavelength limit is likely to be the Planck length, and the long wavelength limit is the size of the universe itself (see physical cosmology), though in principle the spectrum is infinite.

Electromagnetic energy at a particular wavelength λ (in vacuum) has an associated frequency f and photon energy *E*. Thus, the electromagnetic spectrum may be expressed equally well in terms of any of these three quantities. They are related according to the equations:

wave speed (*c*) = *frequency* x *wavelength*

or

$$\lambda = \frac{c}{f}$$

and

$$E = hf$$

or

$$E = hc/\lambda$$

where:

- *c* is the speed of light, 299792458 m/s
  $(c \approx 3 \cdot 10^8 \ \ \mathrm{m/s} = 300{,}000 \ \mathrm{km/s})$.
- *h* is Planck's constant,
  $(h \approx 6.626069 \cdot 10^{-34} \ \mathrm{J \cdot s} \approx 4.13567 \ \mu\mathrm{eV/GHz})$.

So, high-frequency electromagnetic waves have a short wavelength and high energy; low-frequency waves have a long wavelength and low energy.

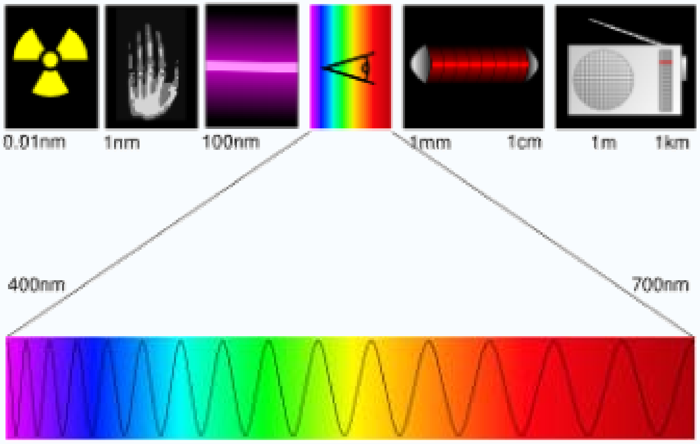
Spectra of objects

Nearly all objects in the universe emit, reflect and/or transmit some light. (One hypothetical exception may be dark matter.) The distribution of this light along the electromagnetic spectrum (called the *spectrum* of the object) is determined by the object's composition. Several types of spectra can be distinguished depending upon the nature of the radiation coming from an object:

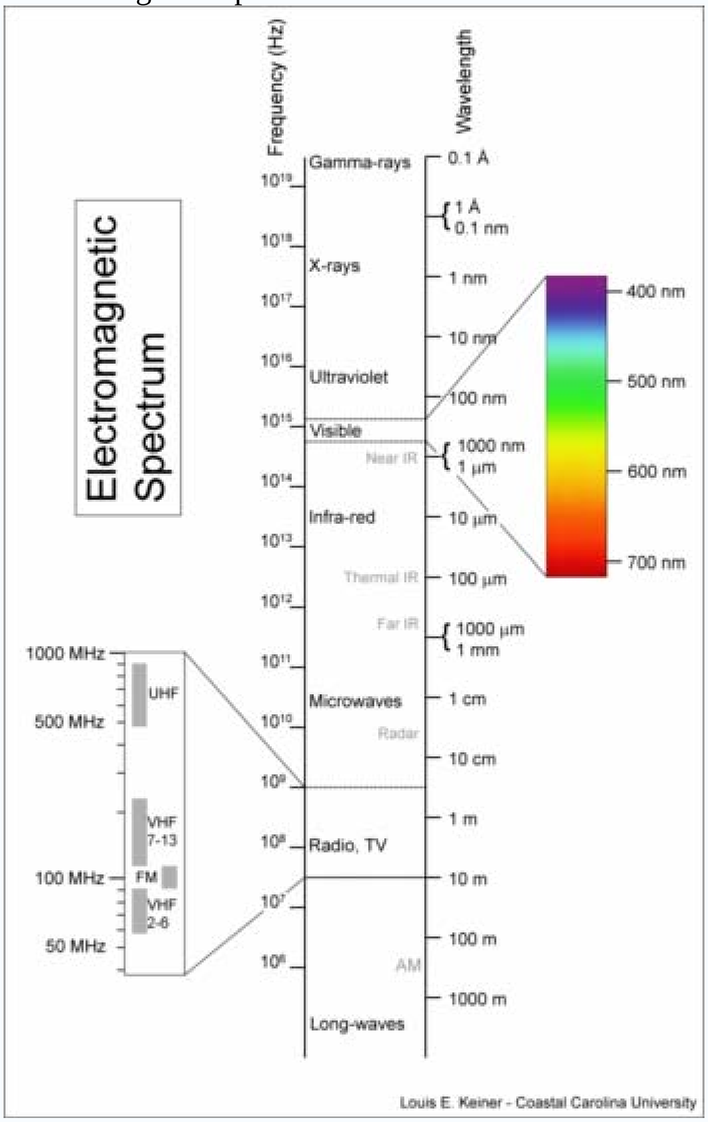
- If the spectrum is composed primarily of thermal radiation emitted by the object itself, an *emission spectrum* occurs.
  - Some bodies emit light more or less according to the blackbody spectrum.
- If the spectrum is composed of background light, parts of which the object transmits and parts of which it absorbs, an *absorption spectrum* occurs.

Electromagnetic spectroscopy is the branch of physics that deals with the characterization of matter by its spectra.

[edit] Classification systems



Electromagnetic spectrum illustration.



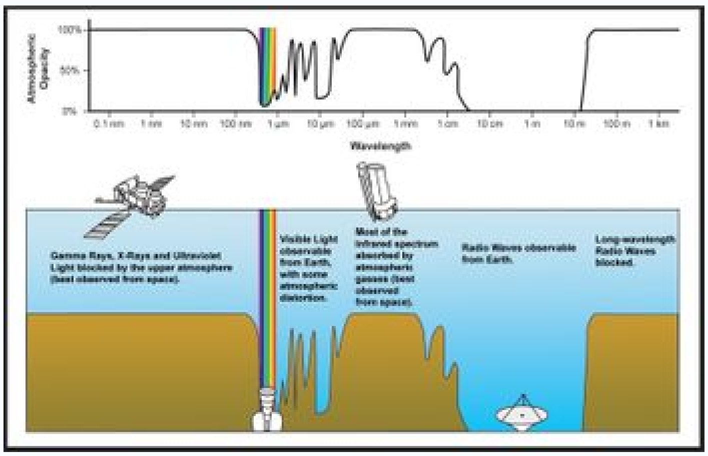
Electromagnetic Spectrum Image.

While the classification scheme is generally accurate, in reality there is often some overlap between neighboring types of electromagnetic energy. For example, SLF radio waves at 60 Hz may be received and studied by astronomers, or may be ducted along wires as electric power. Also, some low-energy gamma rays actually have a longer wavelength than some high-energy X-rays. This is possible because "gamma ray" is the name given to the photons generated from nuclear decay or other nuclear and subnuclear processes, whereas X-rays on the other hand are generated by electronic transitions involving highly energetic inner electrons. Therefore the distinction between gamma ray and X-ray is related to the radiation source rather than the radiation wavelength.

Generally, nuclear transitions are much more energetic than electronic transitions, so usually, gamma-rays are more energetic than X-rays. However, there are a few low-energy nuclear transitions (e.g. the 14.4 keV nuclear transition of Fe-57) that produce gamma rays that are less energetic than some of the higher energy X-rays.

Use of the radio frequency spectrum is regulated by governments. This is called frequency allocation.

Radio frequency



Plot of Earth's atmospheric transmittance (or opacity) to various wavelengths of electromagnetic radiation.

Radio waves generally are utilized by antennas of appropriate size (according to the principle of resonance), with wavelengths ranging from hundreds of metres to about one millimetre. They are used for transmission of data, via modulation. Television, mobile phones, wireless networking and amateur radio all use radio waves.

Microwaves

The super high frequency (SHF) and extremely high frequency (EHF) of Microwaves come next up the frequency scale. Microwaves are waves which are typically short enough to employ tubular metal waveguides of reasonable diameter. Microwave energy is produced with klystron and magnetron tubes,s and with solid state diodes such as Gunn and IMPATT devices. Microwaves are absorbed by molecules that have a dipole moment in liquids. In a microwave oven, this effect is used to heat food. Low-intensity microwave radiation is used in Wi-Fi.

The average microwave oven in active condition is, in close range, powerful enough to cause interference with poorly shielded electromagnetic fields such as those found in mobile medical devices and cheap consumer electronics.

Terahertz radiation

Terahertz radiation is a region of the spectrum between far infrared and microwaves. Until recently, the range was rarely studied and few sources existed for microwave energy at the high end of the band (sub-millimetre waves or so-called terahertz waves), but applications such as imaging and communications are now appearing. Scientists are also looking to apply Terahertz technology in the armed forces, where high frequency waves might be directed at enemy troops to incapacitate their electronic equipment.

Infrared radiation

The infrared part of the electromagnetic spectrum covers the range from roughly 300 GHz (1 mm) to 400 THz (750 nm). It can be divided into three parts:

- **Far-infrared**, from 300 GHz (1 mm) to 30 THz (10 μm). The lower part of this range may also be called microwaves. This radiation is typically absorbed by so-called rotational modes in gas-phase molecules, by molecular motions in liquids, and by phonons in solids. The water in the Earth's atmosphere absorbs so strongly in this range that it renders the atmosphere effectively opaque. However, there are certain wavelength ranges ("windows") within the opaque range which allow partial transmission, and can be used for astronomy. The wavelength range from approximately 200 μm up to a few mm is often referred to as "sub-millimetre" in astronomy, reserving far infrared for wavelengths below 200 μm.

- **Mid-infrared**, from 30 to 120 THz (10 to 2.5 μm). Hot objects (black-body radiators) can radiate strongly in this range. It is absorbed by molecular vibrations, that is, when the different atoms in a molecule vibrate around their equilibrium positions. This range is sometimes called the *fingerprint region* since the mid-infrared absorption spectrum of a compound is very specific for that compound.

- **Near-infrared**, from 120 to 400 THz (2,500 to 750 nm). Physical processes that are relevant for this range are similar to those for visible light.

Visible radiation (light)

Above infrared in frequency comes visible light. This is the range in which the sun and stars similar to it emit most of their radiation. It is probably not a coincidence that the

human eye is sensitive to the wavelengths that the sun emits most strongly. Visible light (and near-infrared light) is typically absorbed and emitted by electrons in molecules and atoms that move from one energy level to another. The light we see with our eyes is really a very small portion of the electromagnetic spectrum. A rainbow shows the optical (visible) part of the electromagnetic spectrum; infrared (if you could see it) would be located just beyond the red side of the rainbow with ultraviolet appearing just beyond the violet end.

Ultraviolet light

Next in frequency comes ultraviolet (UV). This is radiation whose wavelength is shorter than the violet end of the visible spectrum.

Being very energetic, UV can break chemical bonds, making molecules unusually reactive or ionizing them, in general changing their mutual behavior. Sunburn, for example, is caused by the disruptive effects of UV radiation on skin cells, which can even cause skin cancer, if the radiation damages the complex DNA molecules in the cells (UV radiation is a proven mutagen). The Sun emits a large amount of UV radiation, which could quickly turn Earth into a barren desert, but most of it is absorbed by the atmosphere's ozone layer before reaching the surface.

X-rays

After UV come X-rays. Hard X-rays have shorter wavelengths than soft X-rays. X-rays are used for seeing through some things and not others, as well as for high-energy physics and astronomy. Neutron stars and accretion disks around black holes emit X-rays, which enable us to study them.

X-rays will pass through most substances, and this makes them useful in medicine and industry. X-rays are given off by stars, and strongly by some types of nebulae. An X-ray machine works by firing a beam of electrons at a "target". If we fire the electrons with enough energy, X-rays will be produced.

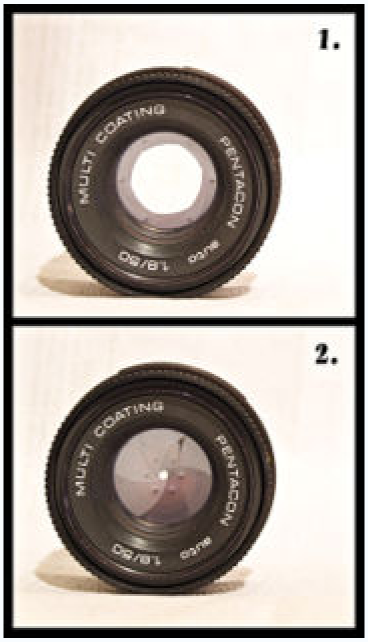
Gamma rays

After hard X-rays come gamma rays. These are the most energetic photons, having no lower limit to their wavelength. They are useful to astronomers in the study of high-energy objects or regions and find a use with physicists thanks to their penetrative ability

and their production from radioisotopes. The wavelength of gamma rays can be measured with high accuracy by means of Compton scattering.

Note that there are no defined boundaries between the types of electromagnetic radiation. Some wavelengths have a mixture of the properties of two regions of the spectrum. For example, red light resembles infra-red radiation in that it can resonate some chemical bonds.

Aperture



a big (1) and a small (2) aperture

In optics, an **aperture** is a hole or an opening through which light is admitted. More specifically, the aperture of an optical system is the opening that determines the cone angle of a bundle of rays that come to a focus in the image plane.

An optical system typically has many openings, or structures that limit the ray bundles (ray bundles are also known as *pencils* of light). These structures may be the edge of a lens or mirror, or a ring or other fixture that holds an optical element in place, or may be a special element such as a diaphragm placed in the optical path deliberately to limit the light admitted by the system. In general, these structures are called **stops**, and the **aperture stop** is the stop that determines the ray cone angle, or equivalently the brightness, at an image point.

In some contexts, especially in photography and astronomy, *aperture* refers to the *diameter* of the aperture stop rather than the physical stop or the opening itself. For example, in a telescope the aperture stop is typically the edges of the objective lens or mirror (or of the mount that holds it). One then speaks of a telescope as having, for example, a 100 centimeter *aperture*. Note that the aperture stop is not necessarily the

smallest stop in the system. Magnification and demagnification by lenses and other elements can cause a relatively large stop to be the aperture stop for the system.

Sometimes stops and diaphragms are called apertures, even when they are not the aperture stop of the system.

The word aperture is also used in other contexts to indicate a system which blocks off light outside a certain region. In astronomy for example, a photometric aperture around a star usually corresponds to a circular window around the image of a star within which the light intensity is summed[1].

Application

The aperture stop is an extremely important element in most optical designs. Its most obvious feature is that it limits the amount of light that can reach the image plane. This can either be undesired, as in a telescope where one wants to collect as much light as possible; or deliberate, to prevent saturation of a detector or overexposure of film. In both cases, the size of the aperture stop is constrained by things other than the amount of light admitted, however:

- The size of the stop is one factor that affects depth of field. Smaller stops produce a longer depth of field, allowing objects at a wide range of distances to all be in focus at the same time.
- The stop limits the effect of optical aberrations. If the stop is too large, the image will be distorted. More sophisticated optical system designs can mitigate the effect of aberrations, allowing a larger stop and therefore greater light collecting ability.
- The stop determines whether the image will be vignetted. Larger stops can cause the intensity reaching the film or detector to fall off toward the edges of the picture, especially when for off-axis points a different stop becomes the aperture stop by virtue of cutting off more light than did the stop that was the aperture stop on the optic axis.
- A larger aperture stop requires larger diameter optics, which are heavier and more expensive.

In addition to an aperture stop, a photographic lens may have one or more *field stops*, which limit the system's field of view. Outside the angle of view, a field stop may become the aperture stop, causing vignetting; vignetting is only a problem if it happens inside the desired field of view.

The pupil of the eye is its aperture; the iris is the diaphragm that serves as the aperture stop. Refraction in the cornea causes the effective aperture (the entrance pupil) to differ slightly from the physical pupil diameter. The entrance pupil is typically about 4 mm in diameter, although it can range from 2 mm ($f/8.3$) in a brightly lit place to 8 mm ($f/2.1$) in the dark.

In astronomy, the diameter of the aperture stop (called the *aperture*) is a critical parameter in the design of a telescope. Generally, one would want the *aperture* to be as large as possible, to collect the maximum amount of light from the distant objects being imaged. The size of the aperture is limited, however, in practice by considerations of cost and weight, as well as prevention of aberrations (as mentioned above).

In photography

The aperture stop of a photographic lens can be adjusted to control the amount of light reaching the film or image sensor. In combination with variation of shutter speed, the aperture size will regulate the film's degree of exposure to light. Typically, a fast shutter speed will require a larger aperture to ensure sufficient light exposure, and a slow shutter speed will require a smaller aperture to avoid excessive exposure.

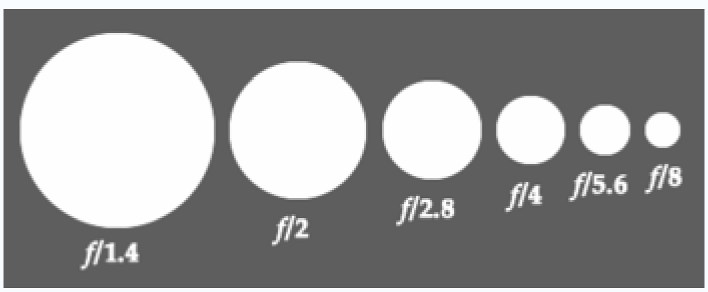


Diagram of decreasing aperture sizes (increasing f-numbers) for "full stop" increments (factor of two aperture area per stop)

A device called a diaphragm usually serves as the aperture stop, and controls the aperture. The diaphragm functions much like the iris of the eye—it controls the effective diameter of the lens opening. Reducing the aperture size increases the depth of field, which describes the extent to which subject matter lying closer than or farther from the actual plane of focus appears to be in focus. In general, the smaller the aerture (the larger the number), the greater the distance from the plane of focus the subject matter may be while still appearing in focus.

The lens aperture is usually specified as an f-number, the ratio of focal length to effective aperture diameter. A lens typically has a set of marked "f-stops" that the f-number can be set to. A lower f-number denotes a greater aperture opening which allows more light to reach the film or image sensor.

Aperture priority refers to a shooting mode used in semi-automatic cameras. It allows the photographer to choose an aperture setting and allow the camera to decide the correct shutter speed. This is sometimes referred to as Aperture Priority Auto Exposure, A mode, Av mode, or semi-auto mode

Maximum and minimum apertures

The specifications for a given lens typically include the minimum and maximum apertures. These refer to the maximum and minimum f-numbers the lens can be set at to achieve, respectively. For example, the Canon EF 70-200mm lens has a maximum aperture of $f/2.8$ and a minimum aperture of $f/32$.

$f/32$ - narrow aperture and low shutter speed

$f/5$ - wide aperture and high shutter speed

The maximum aperture tends to be of most interest; it is known as the lens speed and is always included when describing a lens (e.g., 100-400mm $f/5.6$, or 70-200mm $f/2.8$).

A typical lens will have an f-number range from $f/16$ (small aperture) to $f/2$ (large aperture) (these values vary). Professional lenses for 35mm cameras can have f-numbers as low as $f/1.0$, while professional lenses for some movie cameras can have f-numbers as low as $f/0.75$ (very large relative aperture). These are known as "fast" lenses because they allow much more light to reach the film and therefore reduce the required exposure time. Stanley Kubrick's film Barry Lyndon is notable for having the largest aperture in film history: $f/0.7$.

Large aperture prime lenses (lenses which have a fixed focal length) are favored especially by photojournalists who often work in dim light, have no opportunity to introduce supplementary lighting, and need to capture fast breaking events.

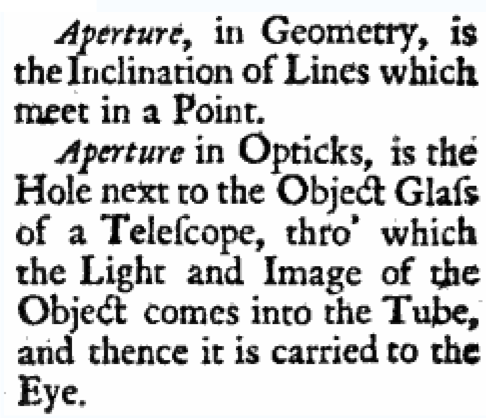
Zoom lenses typically have a maximum aperture (minimum f-number) of *f*/2.8 to *f*/6.3 through their range. A very fast zoom lens will be constant *f*/2.8 or *f*/2, which means the relative aperture will stay the same throughout the zoom range. A more typical consumer zoom will have a variable relative aperture, since it is harder to keep the effective aperture proportional to focal length at long focal lengths; *f*/3.5 to *f*/6.3 would be typical.

In scanning or sampling

The terms *scanning aperture* and *sampling aperture* are often used to refer to the opening through which an image is sampled, or scanned, for example in a drum scanner, an image sensor, or a television pickup apparatus. The sampling aperture can be a literal optical aperture, that is, a small opening in space, or it can be a time-domain aperture for sampling a signal waveform.

For example, film grain is quantified as *graininess* via a measurement of film density fluctuations as seen through a 0.048 mm sampling aperture.

History



Aperture, in Geometry, is the Inclination of Lines which meet in a Point.

Aperture in Opticks, is the Hole next to the Object Glaſs of a Teleſcope, thro' which the Light and Image of the Object comes into the Tube, and thence it is carried to the Eye.

Definitions of *Aperture* in the 1707 *Glossographia Anglicana Nova*

Aperture was defined in the 1707 edition of Thomas Blount's famous *Glossographia Anglicana Nova*[2], and possibly in earlier editions, as follows:

> *Aperture*, in Opticks, is the Hole next to the Object Glass of a Telescope, thro' which the Light and the Image of the Object comes into the Tube, and thence it is carried to the Eye.

The eleventh edition of the Encyclopaedia Britannica (now in the public domain) has this historically interesting passage in the lens section of the photography article:

> In constructing photographic objectives these aberrations and distortions have to be neutralized, by regulating the curves of the different positive and negative component lenses, the refractive and dispersive indices of the glasses from which they are made, and the distances of the refracting surfaces, so as to make the objective as far as possible stigmatic or focusing to a point, giving an image well defined and undistorted. This perfect correction could never be effected in objectives made before 1887, and very few could be effectively used at their full apertures, because although linear distortion could be overcome there were always residual aberrations affecting the oblique rays and necessitating the use of a diaphragm, which by lengthening out the rays caused them to define clearly over a larger surface, at the expense of luminous intensity and rapidity of working. The introduction of rapid gelatin dry plates enabled photographs to be taken with much greater rapidity than before, and led to a demand for greater intensity of illumination and better definition in lenses to meet the requirements of the necessarily very rapid exposures in hand cameras. For studio and copying work quick-acting lenses are also valuable in dull weather or in winter, The rapidity of a lens with a light of given intensity depends upon the diameter of its aperture, or that of the diaphragm used, relatively to the focal length. In order, therefore, to obtain increased rapidity combined with perfect definition, some means had to be found of constructing photographic objectives with larger effective apertures. This necessity had long been recognized and met by many of the best makers for objectives of the single meniscus and aplanatic types, but with only partial success, because such objectives are dependent upon the diaphragm for the further correction necessary to obtain good definition over an extended field. The difficulty was in the removal of astigmatism and curvature of the field, which, as J. Petzval had shown, was impossible with the old optical flint and crown glasses. In 1886

Messrs E. Abbe and 0. Schott, of Jena, introduced several new varieties of optical glasses, among them new crown glasses which, with a lower dispersion than flint glass, have a higher instead of a lower refractive power. It was thus rendered possible to overcome the old difficulties and to revolutionize photographic optics by enabling objectives to be made free from astigmatism, working at their full apertures with great flatness of field independently of the diaphragm, which is now chiefly used to extend the area of definition or angle of view, and the so-called depth of focus for objects in different planes. ...[Lenses] are also sometimes classified according to their rapidity, as expressed by their effective apertures, into extra rapid, with apertures larger than f/6; rapid, with apertures from f/6 to f/8; slow, with apertures less than f/11.

Diaphragm (optics)

A 35mm lens set to f/8; the diameter of the seven-sided entrance pupil, the virtual image of the opening in the iris diaphragm, is 4.375mm

In optics, a **diaphragm** is a thin opaque structure with an opening (aperture) at its centre. The role of the diaphragm is to *stop* the passage of light, except for the light passing through the *aperture*. Thus it is also called a *stop* (an aperture stop, if it limits the brightness of light reacting the focal plane, or a *field stop* or *flare stop* for other uses of diaphragms in lenses). The diaphragm is placed in the lightpath of a lens or objective, and the size of the aperture regulates the amount of light that passes through the lens. The centre of the diaphragm's aperture coincides with the optical axis of the lens system.

Most modern cameras use a type of adjustable diaphragm known as an ***iris diaphragm***, and often referred to simply as an ***iris***.

See the articles on aperture and f-number for the photographic effect and system of quantification of varying the opening in the diaphragm.

Iris diaphragms versus other types

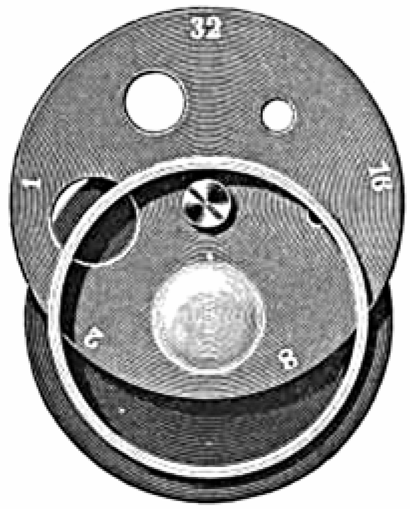


Fig. 50. Rotating Diaphragm.
Carl Zeiss.

A Zeiss rotating diaphragm, 1906[1]. One diaphragm with five apertures.

A natural optical system that has a diaphragm and an aperture is the human eye. The iris is the diaphragm, and the opening in the iris of the eye (the pupil) is the aperture. An analogous device in a photographic lens is called an ***iris diaphragm***.

In the early years of photography, a lens could be fitted with one of a set of interchangeable diaphragms [1], often as brass strips known as Waterhouse stops or Waterhouse diaphragms. In modern cameras, an iris diaphragm is usually used; it has an adjustable opening, like the iris of the eye. Normally, the opening is shaped in a near-round fashion by a number of movable blades. Iris diaphragms usually have five to eight blades, depending on the intended uses, pricing and quality of the device in which it is used. Furthermore, each blade can be curved, resulting in an 'inflated' pentagon (or other polygon) shape, to improve the overall roundness of the iris opening.

Some modern automatic point-and-shoot cameras have a small set of selectable fixed diaphragms, rather than an iris diaphragm (for example, the Polaroid x530 has only two apertures).

The number of blades in an iris diaphragm has a direct relation with the appearance of the blurred out-of-focus areas in an image, also called *Bokeh*. The more blades a diaphragm has, the rounder and less polygon-shaped the opening will be. This results in softer and more gradually blurred out-of-focus areas.

In a photograph, the number of blades that the iris diaphragm has can be guessed by counting the number of spikes converging from a light source or bright reflection. For an odd number of blades, there are twice as many spikes as there are blades.

In case of an even number of blades, the two spikes per blade will overlap each other, so the number of spikes visible will be the number of blades in the diaphragm used. This is most apparent in pictures taken in the dark with small bright spots, for example night cityscapes.

History

Diaphragms are usually metal plates perforated with a central aperture, ranging in diameter in geometrical proportion to the focus of lens. They are used to prevent the transmission of any but those rays which are parallel to the axis of the lens—they increase the definition by their action on the marginal rays, and reduce spherical aberration and increase the focal depth (see FOCUS) by lengthening the pencils of light. For decrease in the diameter of the diaphragm increase in the time of exposure

is requisite, due to the decrease in illumination or quantity of light admitted. Diaphragms are very often termed *stops;* but this is not quite correct, as a stop is placed *in contact* with the lens, and a diaphragm some distance from it. For single lenses the diaphragm is usually placed from $\frac{1}{4}$ to $\frac{1}{5}$ of the focal length in front of the lens, in which position it limits the diameter of the pencils of light, and causes them to cross the axis at the aperture of the diaphragm, before refraction. (See DISTORTION.) The distance of the diaphragm is in many instances when placed in front of the lens the cause of Flare (*q.v.*). This can be obviated by altering the position, one-eighth of an inch either way being generally sufficient to obliterate it. In all symmetrical doublet lenses, the proper position of the diaphragm is equidistant between the two combinations; in unsymmetrical combinations, the position is proportionate to the foci of the combinations. For general use the following maxims should be remembered:—*A large diaphragm gives a bolder picture than a small one; focus with the largest aperture, then insert the smaller diaphragms till sharpness is obtained over the whole screen. The smaller the stop the longer the exposure, also the flatter the field of the lens, and the greater the depth of focus.* The diaphragms should always be numbered with what is termed their focal value—*i.e.*, by the number which expresses their diameter as the fraction of the equivalent focal length of lens. This is usually expressed as f/x. To find this number divide the focal length of the lens by the diameter of diaphragm—*e.g.*, Focal length of lens, $8\frac{1}{2}$ ins.; diameter of diaphragm, $\frac{3}{4}$ in.; $8\frac{1}{2} \div \frac{3}{4} = 11{\cdot}3$; number of diaphragm, $f/11{\cdot}3$. The Photographic Society of Great Britain number the diaphragms, however, in rather a different way, taking $f/4$ as the standard, which they call No. I. This system is termed the "Uniform Standard," or U. S. No., and the U. S. number for any diaphragm marked on the f/x system may be found by the following rule:—Divide the focal length of lens by diameter of diaphragm to f/x, square the result, divide by sixteen, and the result will be the U. S. No. Ex.: Find U. S. No. of diaphragm marked $f/11{\cdot}3$. $11{\cdot}3 \times 11{\cdot}3 = 127{\cdot}69$; $127{\cdot}69 \div 16 = 7{\cdot}98$, or practically 8, U. S. No. The following table, showing at a glance the U. S. No. for all diaphragms, may be of some assistance:—

Lately a new kind of diaphragm, termed the Iris diaphragm, has been introduced, which consists of thin flat tongues of metal fastened to a ring in the lens mount, by means of which the aperture of the diaphragm may be enlarged or diminished by turning the ring backwards or forwards, causing the tongues to contract or enlarge the opening, the use of which obviates all chance of losing or misplacing the diaphragms, but increases the chance of flare, as the friction of the metal tongues wears off the blackening, and causes the edges to become bright. The diaphragms of the ordinary or Waterhouse pattern can be pinned together by a brass rivet just by the tongue, on which the numbers are stamped, thus lessening the chance of losing them.

Dictionary entry for *Diaphragm* in the 1889 Wall's Dictionary of Photography

> "Let us see what takes place when the stop is removed from the lens to a proper distance. In this case the stop becomes a diaphragm.
> * In optics, *stop* and *diaphragm* are synonyms. But in photographic optics they are only so by an unfortunate confusion of language. The stop reduces the lens to its central aperture; the diaphragm, on the contrary, allows all the segments of the lens to act, but only on the different radiating points placed symmetrically and concentrically in relation to the axis of the lens, or of the system of lenses (of which the axis is, besides, in every case common)."

This distinction was maintained in Wall's 1889 *Dictionary of Photography* (see figure), but disappeared after Ernst Abbe's theory of stops unified these concepts.

According to Rudolph Kingslake[4], the inventor of the iris diaphragm is unknown. Others credit Joseph Nicéphore Niépce for this device, around 1820. Mr. J. H. Brown, a member of the Royal Microscopical Society, appears to have invented a popular improved iris diaphragm by 1867[5].

Kingslake has more definite histories for some other diaphragm types, such as M. Noton's adjustable *cat eye* diaphragm of two sliding squares in 1856, and the Waterhouse stops of John Waterhouse in 1858.

Shutter (photography)

In photography, a **shutter** is a device that allows light to pass for a determined period of time, for the purpose of exposing photographic film or a light-sensitive electronic sensor to the right amount of light to create a permanent image of a view. A shutter can also be used to allow pulses of light to pass outwards, as in a movie projector or signal lamp.

Camera shutters

Camera shutters are normally of two basic types:

- Central shutters, shutters mounted within a lens, or more rarely behind or even in front of a lens. One such common shutter is the leaf shutter.
- Focal plane shutters, shutters mounted near the focal plane

Central shutters usually have a diaphragm-like mechanism which progressively dilate to a circular opening the size of the lens, then stay open as long as is required, and finally close. Ideally the opening and closing are instantaneous; in reality this cannot be so. The time taken to dilate, and then to contract, places a lower limit on the exposure time. A less obvious property is that at the highest speeds the shutter is fully open for only a fraction of the exposure; the effective aperture is less, and the depth of field greater, than at lower speeds.

Shutters immediately behind the lens were used in some cameras with limited lens interchangeability. Shutters in front of the lens were used in the early days of photography.

Focal-plane shutters are usually implemented as a pair of cloth, metal, or plastic curtains which shield the film from light. For exposures of, typically, 1/30th of a second or more, one curtain opens, and the second one later closes. For shorter exposures, the two curtains move simultaneously, but leaving a slit-shaped opening through which light can pass. The speed of motion of the curtains and the width of the slit are adjusted so that each part of the film is exposed to light for the required time (the effective exposure), although the assembly may take an appreciable time (typically 1/30") to traverse the film. The effective exposure time can be much shorter than for central shutters.

Focal plane shutters have the advantages of enabling much shorter exposures, and allowing the use of interchangeable lenses without requiring the expense of a separate shutter for each lens. They have the disadvantage of distorting the images of fast-moving objects: although no part of the film is exposed for longer than the time set on the dial, one edge of the film is exposed an appreciable time after the other, so that a horizontally moving shutter will, for example, elongate or shorten the image of a car speeding in the same or the opposite direction to the shutter movement.

Other mechanisms than the dilating aperture and the sliding curtains have been used; anything which exposes the film to light for a specified time will suffice.

The time for which a shutter remains open, the exposure time, is determined by a timing mechanism. These were originally mechanical, but since the late twentieth century are mostly electronic.

The exposure time and the effective aperture of the lens must together be such as to allow the right amount to reach the film or sensor. Additionally, the exposure time must be suitable to handle any motion of the subject. Usually it must be fast enough to "freeze" rapid motion; sometimes a controlled degree of blur is desired, to give a sensation of movement.

Most shutters generate a signal to trigger a flash, if connected. This was quite a complicated matter with mechanical shutters and flashbulbs which took an appreciable time to reach full brightness, but is simple with electronic timers and electronic flash units which fire virtually instantaneously.

Cinematography uses a rotary disc shutter in movie cameras, a continuously spinning disc which conceals the image with a reflex mirror during the intermittent motion between frame exposure. The disc then spins to an open section that exposes the next frame of film while it is held by the registration pin.

Shutter lag

Shutter lag is the time between pressing the shutter release and the camera responding by taking the picture. Ironically, while this delay was insignificant on most film cameras, some digital cameras have shutter lag times on the order of hundreds of milliseconds, which may be a minor annoyance to the user.

Projector shutters

In movie projection, the shutter admits light from the lamphouse to illuminate the film across to the projection screen. To avoid flicker, a double-bladed rotary disc shutter admits light two times per frame of film. There are also some models which are triple-bladed, and thus admit light three times per frame (see Persistence of vision).

Shutters can also be used simply to regulate pulses of light, with no film being used, as in a signal lamp.

Photographic film

Undeveloped Arista black and white film, ISO 125/22°.

Photographic film is a sheet of plastic (polyester, celluloid (nitrocellulose) or cellulose acetate) coated with an emulsion containing light-sensitive silver halide salts (bonded by gelatin) with variable crystal sizes that determine the sensitivity and resolution of the film. When the emulsion is subjected to sufficient exposure to light (or other forms of electromagnetic radiation such as X-rays), it forms a latent (invisible) image. Chemical processes can then be applied to the film to create a visible image, in a process called film developing.

In black-and-white photographic film there is usually one layer of silver salts. When the exposed grains are developed, the silver salts are converted to metallic silver, which block light and appear as the black part of the film *negative*.

Color film uses at least three layers. Dyes added to the silver salts make the crystals sensitive to different colors. Typically the blue-sensitive layer is on top, followed by the green and red layers. During development, the silver salts are converted to metallic silver, as with black and white film. The by-products of this reaction form colored dyes. The silver is converted back to silver salts in the *bleach step* of development. It is removed from the film in the *fix step*. Some films, like Kodacolor II, have as many as 12 emulsion layers, with upwards of 20 different chemicals in each layer.

Because photographic film is widespread in the production of motion pictures, or movies, these are also known as *films*.

Film basics

There are two primary types of photographic film:

- **Print** film, when developed, turns into a **negative** with the colors (or black and white values, in black and white film) inverted. This type of film must be "printed" — either projected through a lens or placed in contact — to photographic paper in order to be viewed as intended. Print films are available in both black-and-white and color.

- **Color reversal film** after development is called a **transparency** and can be viewed directly using a loupe or projector. Reversal film mounted with plastic or cardboard for projection is often called a **slide**. It is also often marketed as "slide" film. This type of film is often used to produce digital scans or color separations for mass-market printing. Photographic prints can be produced from reversal film, but the process is expensive and not as simple as that for print film. Black and white reversal film exists, but is uncommon — one of the reasons reversal films are popular among professional photographers is the fact that they are generally superior to print films with regards to color reproduction. (Conventional black and white negative stock can be reversal- processed, to give 'black & white slides', and kits are available to enable this to be done by home-processors - however, the gamma required for an effective slide is high, and more easily achieved with a slower film like Pan-F).

In order to produce a usable image, the film needs to be exposed properly. The amount of exposure variation that a given film can tolerate while still producing an acceptable level of quality is called its **exposure latitude**. Color print film generally has greater exposure latitude than other types of film. Additionally, because print film must be printed to be viewed, after-the-fact corrections for imperfect exposure are possible during the printing process.

The concentration of dyes or silver salts remaining on the film after development is referred to as optical density, or simply **density**; the optical density is proportional to the logarithm of the optical transmission coefficient of the developed film. A dark image on the negative is of higher density than a more transparent image.

Most films are affected by the physics of silver grain activation (which sets a minimum amount of light required to expose a single grain) and by the statistics of random grain activation by photons. The film requires a minimum amount of light before it begins to expose, and then responds by progressive darkening over a wide dynamic range of exposure until all of the grains are exposed and the film achieves (after development) its maximum optical density.

Over the active dynamic range of most films, the density of the developed film is proportional to the logarithm of the total amount of light to which the film was exposed,

so the transmission coefficient of the developed film is proportional to a power of the reciprocal of the brightness of the original exposure. This is due to the statistics of grain activation: as the film becomes progressively more exposed, each incident photon is less likely to impact a still-unexposed grain, yielding the logarithmic behavior.

If parts of the image are exposed heavily enough to approach the maximum density possible for a print film, then they will begin losing the ability to show tonal variations in the final print. Usually those areas will be deemed to be overexposed and will appear as featureless white on the print. Some subject matter is tolerant of very heavy exposure; brilliant light sources like a bright lightbulb, or the sun, included in the image generally appear best as a featureless white on the print.

Likewise, if part of an image receives less than the beginning threshold level of exposure, which depends upon the film's sensitivity to light - or speed - the film there will have no appreciable image density, and will appear on the print as a featureless black. Some photographers use their knowledge of these limits to determine the optimum exposure for a photograph; for one example, see the Zone system. Most automatic cameras instead try to achieve a particular average density.

Film speed

Film speed describes a film's threshold sensitivity to light. The international standard for rating film speed is the ISO scale which combines both the ASA speed and the DIN speed in the format ASA/DIN. Using ISO convention film with an ASA speed of 400 would be labeled 400/27°. ASA is by far the more popular of the available standards, especially with newer equipment, and is often used interchangeably with the term ISO, although DIN retains popularity in Germany. The prevalence of ASA is reflected in film packaging which normally boldly states the ASA speed of the film on the box, with the full ISO speed printed in smaller type on the reverse or base. A fourth naming standard is the GOST developed by the Russian standards authority. See the film speed article for a table of conversions between ASA, DIN, and GOST film speeds.

Common film speeds include ISO 25, 50, 64, 100, 160, 200, 400, 800, 1600, and 3200. Consumer print films are usually in the ISO 100 to ISO 800 range. Some films, like Kodak's Technical Pan, are not ISO rated and therefore careful examination of the film's properties must be made by the photographer before exposure and development. ISO 25

film is very "slow", as it requires much more exposure to produce a usable image than "fast" ISO 800 film. Films of ISO 800 and greater are thus better suited to low-light situations and action shots (where the short exposure time limits the total light received). The benefit of slower films is that it usually has finer grain and better colour rendition than fast film. Professional photographers usually seek these qualities, and therefore require a tripod to stabilize the camera for a longer exposure. **Grain size** refers to the size of the silver crystals in the emulsion. The smaller the crystals, the finer the detail in the photo and the slower the film.

A film with a particular ISO rating can be **pushed** to behave like a film with a higher ISO. In order to do this, the film must be developed for a longer amount of time or at a higher temperature than usual. This procedure is usually only performed by photographers who do their own development or professional-level photofinishers. More rarely, a film can be **pulled** to behave like a "slower" film.

History of film

Pioneering work on the light sensitivity of films was done by Hurter & Driffield from 1876 onwards; this work enabled the first quantitative measure of film speed to be devised.

The first flexible photographic film was made by Eastman Kodak in 1885. This "film" was coated on paper. The first transparent plastic film was produced in 1889. Before this, glass photographic plates were used, which were far more expensive and cumbersome, albeit also of better quality. Early photography in the form of daguerreotypes did not use film at all.

The development of digital photography has significantly reduced the use of film. As of 2006, film is disappearing from the consumer market except for low-end disposable cameras in western countries. This is not true of other markets, in particular the asian market where film is still the predominant product over digital. Although many professionals have turned to digital in the past five years, companies such as Kodak and Fuji have recognised that there is a need for transparency film in the pro market and Fuji have maintained that they intend to continue to manufacture transparency film having kept their word by producing new emulsions during 2006. They have recognised that most users of transparency film are owners of high end film SLRs and that many pros

prefer a choice for their personal work. The availability of film is also of importance to manufacturers such as Leica, whose film based M series rangefinders have a vast following worldwide. What is likely to happen is that film will be less readily available in western countries. Shops such as Jessops in the UK have run down supplies of transparency film for instance to the point where it can no longer be guaranteed to be stocked in a number of their outlets. This however must be balanced against the growth of internet sales in film where companies such as Mailshots can offer stocks of film for a far lesser cost than most shop based outlets.

Special films

Instant photography, as popularised by Polaroid, uses a special type of camera and film that automates and integrates development, without the need of further equipment or chemicals. This process is carried out immediately after exposure, as opposed to regular film, which is developed afterwards and requires additional chemicals. See instant film.

Specialty films exist for recording non-visible portions of the electromagnetic spectrum. These films are usually designed to record either ultraviolet or infrared light. These films can require special equipment; for example, most photographic lenses are made of glass and will therefore filter out most ultraviolet light. Instead, expensive lenses made of quartz must be used. Infrared films may be shot in standard cameras using an infrared band- or long-pass filter.

Exposure and focusing are also difficult when using UV or IR film with a regular camera and lens. The ISO standard for film speed only applies to visible light, so regular light meters are nearly useless. Film manufacturers can supply suggested equivalent film speeds under different conditions, and recommend heavy bracketing. e.g *with a certain filter, assume ISO 25 under daylight and ISO 64 under tungsten lighting*. This allows a light meter to be used to estimate an exposure. For focusing, the focal point for IR is slightly father away from the camera than visible light, and UV slightly closer. Apochromatic lenses are sometimes recommended due to their improved focusing across the spectrum.

Film optimized for sensing X-ray radiation is commonly used for medical imaging, and personal monitoring, and film optimized for sensing gamma rays is sometimes used for radiation dosimetry.

Film leaves much to be desired as a scientific detector: it is difficult to calibrate for photometry, it is not re-usable, it requires careful handling (including temperature and humidity control) for best calibration, and it generally requires a physical object (the film itself) to be returned to the laboratory. Nevertheless, photographic film can be made with a higher spatial resolution than any other type of imaging detector, and (because of its logarithmic response to light) has a wider dynamic range than most digital detectors. For example, Agfa 10E56 holographic film has an equivalent resolution of over 4,000 lines/mm -- equivalent to a pixel size of just 0.125 micrometres -- and an active dynamic range of over five orders of magnitude in brightness, compared to typical scientific CCDs that might have ~10 micrometre pixels and a dynamic range of three to four orders of magnitude.

Common sizes of film

- 135 (popularly known as "35 mm")
- APS (Advanced Photo System)
- 110
- 126
- 127
- 120/220 (for use in medium format photography)
- Sheet film (for use in large format photography)
- Disc film Obsolete format used in disc system cameras
- Motion picture films: 8 mm, 16 mm, 35 mm and 70 mm

Companies that manufacture photographic film

- Agfa-Gevaert
- Bergger (European company composed of former Guilleminot employees.)
- Efke
- Foma
- Forte
- Ferrania
- Fujifilm
- Ilford
- Imation (Spin-off company of 3M has since sold the film business to Ferrania)
- Kodak
- Konica
- Lucky
- Maco
- Orwo
- Perutz
- Polaroid

- ProClick
- Solaris
- Svema
- Tasma
- Tura

Film manufacturers commonly make film that is branded by other companies. Modern films have bar codes on the edge of the film which can be read by a bar code reader. This is because film is sometimes processed differently according to specifications of the film, determined by its manufacturer; the bar code is entered into the computer printer before the film is printed.

To establish the OEM, read the bar code printed on the cassette. Divide the long number by 16 and record the number before the decimal, then multiply the number after the decimal by 16, this could give you a result such as 18 and 2.

The first number is known as the PRODUCT (film manufacturer) and the second number as the MULTIPLIER (speed of the film ISO). In the previous example, 18 identifies 3M as the manufacturer and 2 means it is 200 ISO:

- 3M = 18
- Agfa = 17 or 49
- Kodak = 80, 81, 82 or 88

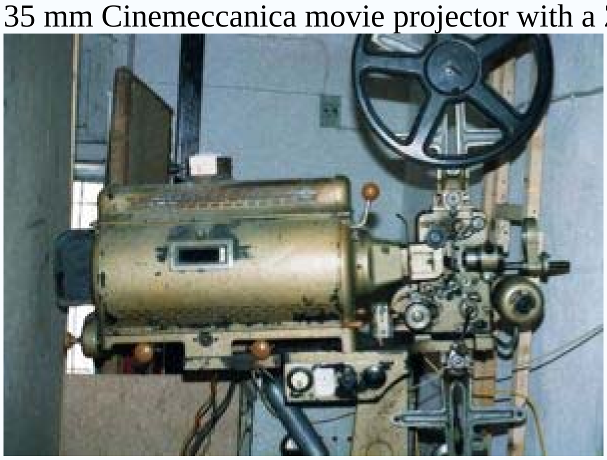
Notable films

- Kodak Kodachrome is one of the oldest slide films still being produced and is known for its long archive stability.
- Fuji Velvia, also a slide film, is known for its high contrast and hyper-saturated colours. It is popular with landscape and nature photographers.
- Both *Kodak T-max p3200* and *Ilford Delta 3200* are B&W films with very wide exposure lattitude. They are rated at roughly ISO 1000, but can be **pushed** to ISO 3200 or higher. Rated speeds of as high as ISO 25,000 have been obtained.
- Kodak Technical Pan, which has now been discontinued, is a widely acclaimed slow black and white film. With a speed of ISO 25, it gave clear, incredibly fine-grained results. It has now become somewhat of a commodity item among photographers as very limited, if any stock remains at photographic suppliers.
- Maco IR 820c / Rollei IR are one of the two last remaining infrared films. After Konica's discontinuation of their IR 750 film and taking into account Kodak HIE's uncertain future, this infrared film is the only one that is certain to remain in the near future. It is very slow and is sensitive to infrared light of up to about 820 nm in wavelength.

Movie projector

35 mm Kinoton movie projector in operation.

35 mm Cinemeccanica movie projector with a Zenith X4000H lamphouse



35 mm movie projector.

A **movie projector** is an opto-mechanical device for displaying moving pictures by projecting them on a projection screen. Most of the optical and mechanical elements, except for the illumination and sound devices, are present in movie cameras.

Physiology

According to the theory of persistence of vision, the perceptual processes of the brain and the retina of the human eye retains an image for a brief moment of time. This theory is said to account for the illusion of motion which results when a series of film images are displayed in quick succession, rather than the perception of the individual frames in the series.

Persistence of vision should be compared with the related phenomena of beta movement and phi movement. A critical part of understanding these visual perception phenomena is that the eye *is not a camera*, ie: there is no "frame rate" or "scan rate" in the eye. Instead, the eye/brain system has a combination of motion detectors, detail detectors and pattern detectors, the outputs of all of which are combined to create the visual experience.

The frequency at which flicker becomes invisible is called the flicker fusion threshold, and is dependent on the level of illumination. Generally, the frame rate of 16 frames per second (fps) is regarded as the lowest frequency at which continuous motion is perceived by humans. (Interestingly this threshold varies across different species; a higher proportion of rod cells in the retina will create a higher threshold level.)

It is possible to view the black space between frames and the passing of the shutter by the following technique:
Close your eyelids, then periodically rapidly blink open and closed. If done fast enough you will be able to randomly "trap" the image between frames, or during shutter motion. This will not work with television due to the persistence of the phosphors nor with LCD or DLP light projectors due to the continuity of image, although certain color artifacts may appear with some digital projection technologies.

Since the birth of sound film, virtually all film projectors in commercial movie theaters project at a constant speed of 24 fps. This speed was chosen for financial and technical reasons - it was the slowest speed (and thus required the least film stock and was cheapest for producers) at which a satisfactory reproduction and amplification of sound could be conducted. There are some specialist formats (eg Showscan and Maxivision) which project at higher rates, often 48 fps.

Silent films usually were not projected at constant speeds [1] but rather were varied throughout the show at the discretion of the projectionist, often with some notes provided

by the distributor. Speeds ranged from about 18 fps on up - sometimes even faster than modern sound film speed (24 fps). Contrary to received opinion, 16 fps - though sometimes used as a camera shooting speed - was dangerously inadvisable for projection, due to the high risk of the nitrate-base prints catching fire in the projector. (A dramatic rendition of a nitrate print fire and its potentially devastating effects is famously found in *Nuovo Cinema Paradiso*, which revolves around the goings-on of a projectionist.)

Principles of operation

35 mm Kinoton FP30ST movie projector, with parts labeled. (Click thumbnail for larger text.)

Projection elements

As in a slide projector there are essential optical elements:

Light source

An incandescent lamp or an electric arc light produces illuminating photons. The traditional carbon arc or modern xenon arc light source produces sufficient heat to burn the film should the film remain stationary for more than a fraction of a second. Xenons were introduced in the 1950s and are now the more common source, being easier and safer to maintain for the most part.

Reflector and condenser lens

A curved reflector redirects light that would otherwise be wasted toward the condensing lens.

A positive curvature lens concentrates the reflected and direct light toward the film gate.

Douser

A metal blade which cuts off light before it can get to the film - usually this is part of the lamphouse. Some projectors have both a manually controlled and electronically one each; the electronic one is used for changeovers. Dousers protect the film when the lamp is on but the film is not moving, preventing the film from melting from prolonged exposure to the direct heat of the lamp. It also prevents the lens from scarring or cracking on the projector.

Film gate and single image

A single image of the series of images comprising the movie is positioned and held flat within an aperture called the gate. The gate also provides a slight amount of friction so that the film does not advance or retreat except when driven to advance the film to the next image.

Shutter

A commonly-held misconception is that film projection is simply a series of individual frames dragged very quickly past the projector's intense light source; this is not the case. If a roll of film were merely passed between the light source and the lens of the projector, all that would be visible on screen would be a continuous blurred series of images sliding from one edge to the other. It is the shutter that gives the illusion of one full frame being replaced exactly on top of another full frame. A rotating petal or gated cylindrical shutter interrupts the emitted light during the time the film is advanced to the next frame. The viewer does not see the transition, thus tricking the brain into believing a moving image is on screen. Modern shutters are designed with a flicker-rate of two or even sometimes three times the frame rate of the film, so as to reduce the perception of screen flickering.

Imaging lens and aperture plate

A lens system with multiple optical elements directs the image of the film to a viewing screen. Different lenses are used for different aspect ratios. Each of these lenses comes with an aperture plate, a piece of metal with a precisely cut rectangular hole in the middle of equivalent aspect ratio. The aperture plate is placed just behind the gate, and masks off

any light from hitting the image outside of the area intended to be shown (most modern films have extra image on the frame that is meant to be masked off in the projector).

Viewing screen

In most cases this is a reflective surface which may be either aluminized (for high contrast in moderate ambient light) or a white surface with small glass beads (for high brilliance under dark conditions). In a commercial theater, the screen also has hundreds of small, evenly spaced holes in order to allow the passage of sound from the speakers and subwoofer which often are directly behind it.

Film transport elements

Film supply and takeup

Two reel system

The two reel system is also known as a changeover system, after the switching mechanism that operates between the end of one reel and the beginning of the next. In a two reel system the feed reel has a slight drag to maintain tensioning in the film, while the takeup reel is driven with a constant tension by a mechanism that is allowed to slip.

The two reel system was almost universally used before the advent of the single reel system for movie theaters in order to be able to show feature-length films. Although one reel long-play systems tend to be more popular with the newer multiplexes, the two reel system is still in significant use to this day. The projector operator operates two projectors, threading one with the next reel while the other projector plays the current reel. As the current reel approaches its end, the projectionist looks for cues, also known as cigarette burns, at the upper right corner of the picture. Usually these are dots or circles, although they can also be slashes. (Some older films have occasionally been known to have used squares or triangles, and even positioned the cues in the middle of the right edge of the picture.) The first cue appears twelve feet (3.7 m) or eight seconds at 24 frame/s before the end of the reel, and signals the projectionist to start the motor of the projector containing the next reel. After another ten and a half feet (3.2 m) or seven seconds at 24 frame/s, the changeover cue should appear, which signals the projectionist to actually make the changeover. When this second cue appears, the projectionist has one and a half feet (457 mm) or one second at 24 frame/s to make the changeover - if it doesn't occur within one second, the tail black leader of the exhausted reel will be

projected on the screen. On some projectors, the operator would be alerted to the change by a bell that operated when the feed reel rotation exceeded a certain speed (that reel rotates faster as the film is exhausted), or based on the diameter of the remaining film (Premier Changeover Indicator Pat.411992), although many such projectors do not have such an auditory system.

During the actual operation of a changeover, the two projectors use an interconnected electrical control connected to the changeover button so that as soon as the button is pressed, the douser on the old reel is closed in sync with the douser for the new reel. If done properly, a changeover should be virtually unnoticeable to an audience. In older theaters, there may be manually operated, sliding covers in front of the projection booth's windows. A changeover with this system is often clearly visible as a wipe on the screen.

The size of the reels can vary based on the projectors, but generally films are divided and distributed in reels of roughly 2000 feet (610 m) about 22 minutes at 24 frame/s. Some projectors can even accommodate up to 6000 feet (1,830 m), which minimizes the number of changeovers in a showing. Certain countries also divide their film reels up differently; Russian films, for example, often come on 1000 foot (305 m) reels, although it's likely that most projectionists working with changeovers would combine them into longer reels of at least 2000 feet (610 m), to minimize changeovers and also give sufficient time for threading and any possibly needed troubleshooting time.

Single reel system

Christie AW3 platter, BIG SKY Industries console, and Century SA projector.

There are two largely used single reel systems (also known as long-play systems) today: the tower system (vertical feed and takeup) and the platter system (horizontal feed and takeup).

The tower system largely resembles the two reel system, except in that the tower itself is generally a separate piece of equipment used with a slightly modified standard projector.

The feed and takeup reels are held vertically on the axis, except behind the projector, on oversized spools with 12,000 foot (3,660 m) capacity or about 133 minutes at 24 frame/s. This large capacity alleviates the need for a changeover on an average-length feature; all of the reels are spliced together into one giant one. The tower is designed with four spools, two on each side, each with its own motor. This allows the whole spool to be immediately rewound after a showing; the extra two spools on the other side allow for a film to be shown while another is being rewound or even made up directly onto the tower. Each spool requires its own motor in order to set proper tensioning for the film, since it has to travel (relatively) much further between the projector film transport and the spools. As each spool gains or loses film, the tension must be periodically checked and adjusted so that the film can be transported on and off the spools without either sagging or snapping.

In a platter system the individual 20 minute reels of film are also spliced together as one large reel, but the film is then wound onto a horizontal rotating table called a platter. Three or more platters are stacked together to create a platter system. Most of the platters in a platter system will be occupied by film prints; whichever platter happens to be empty serves as the "take-up reel" to receive the film that is playing from another platter.

The way the film is fed from the platter to the projector is not unlike an eight-track audio cartridge. Film is unwound from the center of the platter through a mechanism called a "brain" which controls the speed of the platter's rotation so that it matches the speed of the film as it is fed to the projector. The film winds through a series of rollers from the platter stack to the projector, through the projector, through another series of rollers back to the platter stack, and then onto the platter serving as the take-up reel.

This system makes it possible to project a film multiple times without needing to rewind it. As the projectionist threads the projector for each showing, he transfers the brain mechanism from the empty platter to the full platter and the film then plays back onto the platter it came from. In the case of a double feature, each film plays from a full platter onto an empty platter, swapping positions on the platter stack throughout the day.

The advantage of a platter is that the film isn't subjected to the stresses of being rewound each show. Rewinding risks rubbing the film against itself, which can cause scratching of the film and smearing of the emulsion which carries the pictures. The disadvantages of the platter system are that the film can acquire diagonal scratches on it if proper care is

not taken while threading film from platter to projector, and the film has more opportunity to collect dust and dirt as long lengths of film are exposed to the air. A clean projection booth kept at the proper humidity is of great importance, as are cleaning devices that can remove dirt from the film print as it plays.

Automation and the rise of the multiplex

The single reel system can allow for the complete automation of the projection booth operations, given the proper auxiliary equipment. Since films are still transported in multiple reels they must be joined together when placed on the projector reel and taken apart when the film is to be returned to the distributor. It is the complete automation that has enabled the modern "multiplex" cinema - a single site typically containing from 16 to 24 theaters with only a few projection and sound technicians, rather than a platoon of projectionists. The multiplex also offers a great amount of flexibility to a theater operator, enabling theaters to exhibit the same popular production in more than one auditorium with staggered starting times. It is also possible, with the proper equipment installed, to "interlock", i.e. thread a single length of film through multiple projectors. This is very useful when dealing with the mass crowds that an extremely popular film may generate in the first few days of showing, as it allows for a single print to serve more patrons.

Feed and extraction sprockets

Smooth wheels with triangular pins called sprockets engage perforations punched into one or both edges of the film stock. These serve to set the pace of film movement through the projector and any associated sound playback system.

Film loop

As with motion picture cameras, the intermittent motion of the gate requires that there be loops above and below the gate in order to serve as a buffer between the constant speed enforced by the sprockets above and below the gate and the intermittent motion enforced at the gate. Some projectors also have a sensitive trip pin above the gate to guard against the upper loop becoming too big. If the loop hits the pin, it will close the dousers and stop the motor to prevent an excessively large loop from jamming the projector.

Film gate pressure plate

A spring loaded pressure plate functions to align the film in a consistent image plane, both flat and perpendicular to the optical axis. It also provides sufficient drag to prevent film motion during the frame display, while still allowing free motion under control of the intermittent mechanism. The plate also has spring-loaded runners to help hold film while in place and advance it during motion.

Intermittent mechanism

The intermittent mechanism can be constructed in different ways. For smaller gauge projectors (8 mm and 16 mm), a pawl mechanism engages the film's sprocket hole one side, or holes on each side. This pawl advances only when the film is to be moved to the next image. As the pawl retreats for the next cycle it is drawn back and does not engage the film. This is similar to the claw mechanism in a motion picture camera.

In 35 mm and 70 mm projectors, there usually is a special sprocket immediately underneath the pressure plate known as the intermittent sprocket. Unlike the all the other sprockets in the projector, which run continuously, the intermittent sprocket operates in tandem with the shutter, and only moves while the shutter is blocking the lamp, so that the motion of the film cannot be seen. It also moves in a discrete amount at a time, equal to the number of perforations that make up a frame (4 for 35 mm, 5 for 70 mm). The intermittent movement in these projectors is usually provided by a Maltese Cross mechanism.

IMAX projectors use what is known as the rolling loop method, in which each frame is sucked into the gate by a vacuum, and positioned by registration pins in the perforations corresponding to that frame.

Types of projectors

Projectors are classified by the size of the film used, i.e. the film format. Typical film sizes:

8 mm

Long used for home movies before the video camera, this uses double sprocketed 16 mm film, which is run through the camera twice. The 16 mm film is then split lengthwise into

two 8 mm pieces that are spliced to make a single projectable film with sprockets on one side.

Super 8

Developed by Kodak this film stock uses very small sprocket holes close to the edge that allow more of the film stock to be used for the images. This increases the quality of the image. The film is premade in the 8 mm width, not split during processing as is the earlier 8 mm. Magnetic stripes could be added to carry encoded sound to be added after film development.

16 mm

This was a popular format for audio-visual use in schools and as a high-end home entertainment system before the advent of broadcast television. It is also the smallest format that can carry an optically encoded sound track.

35 mm

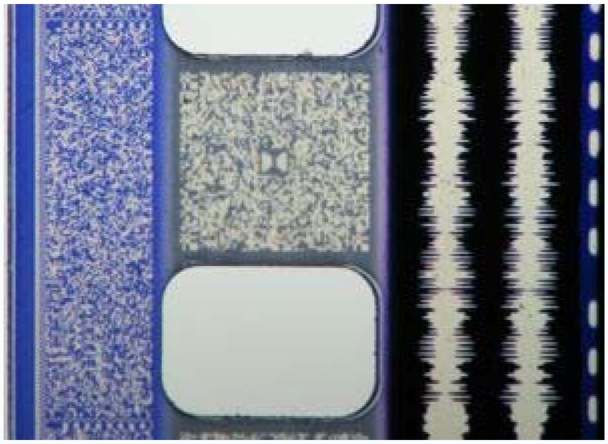
The most common film size for theatrical productions during the first half of the 20th century. In fact, the common 35 mm camera, developed by Leica was designed to use this film stock and was originally intended to be used for test shots by movie directors and cinematographers.

70 mm

High end movie productions are often shot using this size and some theaters are capable of projecting it. 70 mm film is also used in both the flat and domed IMAX projection system. In IMAX the film is oriented for even more effective image area than in other formats.

Some high quality productions intended for 35 mm anamorphic release are shot in and the master prints constructed using 70 mm film stock. A 35 mm print made from a 70 mm master print is significantly better in appearance than an all 35 mm process.

Sound



35mm film audio tracks, from left to right: SDDS, Dolby Digital, analog optical, and DTS time code.

Regardless of the sound format, any sound represented on the film image itself will not be the sound for the particular frame it occupies. All optical sound formats must be offset from the image because the image is projected with intermittent motion. If the sound head on the projector was adjacent to the gate, the sound would be a jerky start-stop-start-stop and so on. Therefore the sound head requires continuous motion and will be located a certain number of frames before or after the gate.

Optical

With 16 mm and the larger sizes it is practical to add a narrow channel of optically encoded sound track. This is read using an illuminating light or laser and a photocell or photodiode. In 16 mm, this is a single mono track, and the sound head is 26 frames after the gate. In 35 mm, this can be mono or stereo, the latter including several different Dolby sound matrixing systems (including Dolby A and Dolby SR). The sound head is located twenty frames after the gate for 35 mm projectors. Originally optical sound was *variable density*, where the transparency/opacity level of the sound track was used to represent sound. This had disadvantages because the grain of the film caused a background hiss, and so was replaced with the now-universal standard *variable area*. In this system, a clear waveform on black background represents the sound, and the width of the waveform is equivalent to the amplitude. Variable area does have slightly less frequency response than variable density, it should be noted. In the 1970s and early 1980s, optical sound Super-8 mm copies were produced mainly for airline in-flight movies. This technology was soon made obsolete by video equipment.

Digital

Modern theatrical systems use optical representations of digitally encoded multi-channel sound. An advantage of digital systems is that the offset between the sound and picture heads can be varied and then set with the digital processors. Digital sound heads are usually above the gate. All digital sound systems currently in use have the ability to instantly and gracefully fall back to the optical sound system should the digital data be corrupt or the whole system fail.

Cinema Digital Sound (CDS)

Created by Kodak and ORC (Optical Radiation Corporation), Cinema Digital Sound was the first attempt to bring multi-channel digital sound to first-run theaters. CDS was available on both 35 mm and 70 mm films. Film prints equipped with CDS did not have the conventional analog optical or magnetic soundtracks to serve as a "back-up" in case the digital sound was unreadable. Another disadvantage of not having an analog back-up track is that CDS required extra film prints be made for the theaters equipped to play CDS. The three formats that followed, Dolby Digital, DTS and SDDS, can co-exist with each other and the analog optical soundtrack on a single version of the film print. This means that a film print carrying all three of these formats (and the analog optical format, usually Dolby SR) can be played in whichever format the theater is equipped to handle. CDS did not achieve wide-spread use and ultimately failed. It premiered with the film *Dick Tracy* and was used with several other films, such as *Days of Thunder* and *Terminator 2: Judgement Day*.

Sony Dynamic Digital Sound (SDDS)

SDDS sound runs on the outside of 35 mm film, between the perforations and the edges, on both edges of the film. SDDS was the first digital system that could handle up to eight tracks of sound. The additional two tracks are for an extra pair of screen channels (Left Center and Right Center) located between the 3 regular screen channels (Left, Center and Right). A pair of CCD's located in a unit above the projector read the two SDDS tracks. The information is decoded and decompressed before being passed along to the cinema sound processor. By default, SDDS units use an onboard Sony Cinema Sound Processor, and when the system is set up in this manner, the theatre's entire sound system can be equalized in the digital domain. In contrast, both DTS and Dolby Digital soundtracks must be passed through to standard analog Dolby cinema sound processors - which are

also used for analog optical sound, so equalization of the sound remains in the analog domain. The audio data in a SDDS track is compressed in the 20-bit ATRAC2 compression scheme at a ratio of about 4.5:1. SDDS premiered with the film *Last Action Hero*.

Dolby Digital

Also known as Spectral Recording Digital or "SR•D." Sound is printed between the perforations and is 26 frames before the picture (the offset can be varied based on processing presets). There are two types of Dolby Digital: SR•D EX, an 8 channel digital system, and SR•D, a 6 channel digital system. The audio data in a Dolby Digital track is compressed in the 16-bit AC-3 compression scheme at a ratio of about 12:1. The images between each perforation are read by a CCD located either above the projector or in the regular analog sound head below the film gate. The information is then decoded, decompressed, and converted to analog by an SR-D processor before going to a standard Dolby analog multi-format cinema sound processor. A consumer version of Dolby Digital is also used on most DVD's, often at higher data rates than the original film. Dolby Digital officially premiered with the film *Batman Returns*, but it was earlier tested at some screenings of *Star Trek: The Undiscovered Country*.

Digital Theater Systems (DTS)

DTS actually stores the sound information on separate CD-ROMs supplied with the film. The CDs are fed into a special modified computer (usually a 386 or 486 system) which syncs up with the film through the use of DTS time code, decompresses the sound, and passes it through to a standard analog Dolby processor. The time code is placed between the optical sound tracks and the actual picture, and is read by an optical LED ahead of the gate. The time code is actually the only sound system which is not offset within the film from the picture, but still needs to be physically set offset ahead of the gate in order to maintain continuous motion. Each disc can hold slightly over two hours of sound, so longer films will require a second disc. Three types of DTS sound exist: DTS-ES (Extended Surround), an 8 channel digital system; DTS-6, a 6 track digital system, and a now obsolete 4 channel system. The audio data in a DTS track is compressed in the 20-bit APTX-100 compression scheme at a ratio of about 4.5:1. Of the three digital formats currently in use, DTS is the only one that has been used with 70 mm presentations. DTS was premiered on *Jurassic Park*. A consumer version of DTS is available on some DVDs.

Magnetic sound

70 mm, which had no optical sound, used the 5 millimeters gained between the 65 mm negative and the final release print to place three magnetic tracks on each side of the perforations, for a total of six tracks. Unlike all other non-double head magnetic sound, 70 mm magnetic heads are located before the gate. Until the introduction of digital sound, it was fairly common for 35 mm films to be blown up to 70 mm often just to take advantage of the greater number of sound tracks. 35 mm four-track magnetic sound was used from the 1950s through the mid 1970s for big-budget feature prints. It was of excellent quality, although somewhat prone to damage and erasure over time. As analog optical stereo gained popularity (it was also more durable and far less expensive to include on a film print), 35 mm four-track magnetic sound was increasingly only used for special road show screenings, and the development of digital sound systems made it completely obsolete.

35 mm and 16 mm each are sometimes run in sync with a separate reel of magnetic sound (known as double head projection because two reels are running on one projector in sync); the image goes through a gate while the magnetic reel passes over a sound head. Since the sound is on a separate reel, it does not need to be offset from the image. This system is usually used only for very low-budget or student productions, or for screening rough cuts of films before the creation of a final married print. Sync between the two reels is checked with SMPTE leader, also known as countdown leader. If the two reels are synced, there should be one frame of "beep" sound exactly on the "2" frame of the countdown - 2 seconds or 48 frames before the picture start.

On certain stocks of Super 8 and 16 mm an iron-oxide sound recording strip was added for the direct synchronous recording of sound which could then be played by projectors with a magnetic sound head. It has since been discontinued by Kodak on both gauges.

Leaders

Academy leader is placed at the head of release prints containing information for the projectionist and featuring numbers which are black on a clear background, counting from 11 to 3 at 16 frame intervals (35mm).

SMPTE leader is placed at the head of release prints or video masters containing information for the projectionist or video playback tech. The numbers count down from 8

to 2 at 24 frame intervals ending at the first frame of the "2" followed by 47 frames of black.

Types of lenses and screens

Orthographic

Before the advent of certain wide screen technologies, lenses always reproduced the exact proportions of the film image onto the screen. Such lenses are relatively simple to design and manufacture. Prior to modern wide screen, the industry standard image ratio of width to height was 4:3.

35 mm VistaVision was a wide screen orthographic system. The wide image was obtained by running the film horizontally across the gate so that the width limitation of the film was transformed to a height limitation. See the VistaVision article for more information.

Anamorphic

Simulated wide screen image with 1.96 to 1 ratio as it would be seen in a camera viewfinder or on a theater screen

Simulated anamorphed image with 1.333 to 1 ratio (4:3) as it would appear on a frame of film

The 1950's saw the development of wide screen films using special lenses for filming and projection. The images on these films retained the same proportions as in the earlier films (a 4:3 width to height ratio). The wide image is compressed onto the film in the camera using additional cylindrical elements within the lens, with a corresponding lens used in the projector to expand the image to the wide screen. This technique is called anamorphic projection and various implementations have been marketed under several brand names, including CinemaScope, Panavision and Superscope, with Technirama implementing a slightly different anamorphic technique using vertical expansion to the film rather than horizontal compression. Of the anamorphic methods, arguably the best image was produced by the Todd-AO (for Michael Todd and American Optical) using 70 mm film and a large, curved screen. The 1956 version of *Around the World in Eighty Days* starring David Niven and Cantinflas was the leading general release production using this process. It could be said that watching the Cinemascope print of this movie instead of the Todd-AO original is like watching a movie on television rather than in a movie theater. Similar 70 mm processes include Super (and Ultra) Panavision and VistaVision.

Fish eye with dome

The IMAX® dome projection method (called "OMNIMAX®") uses 70 mm film oriented to maximize the image area and extreme wide angle lenses to obtain an almost hemispherical image. The field of view is tilted, as is the projection hemisphere, so one may view a portion of the ground in the foreground. Owing to the great area covered by the picture it is not as bright as seen with flat screen projection, but the immersive qualities are quite convincing. While there are not many theaters capable of displaying this format there are regular productions in the fields of nature, travel, science, and

history, and productions may be viewed in most U.S. large urban regions. These dome theaters are mostly located in large and prosperous science and technology museums.

Wide and deep flat screen

The IMAX® flat screen system uses large format film, a wide and deep screen, and close and quite steep "stadium" seating. The effect is to fill the visual field to a greater degree than is possible with conventional wide screen systems. Like the IMAX® dome, this is found in major urban areas, but unlike the dome system it is practical to reformat existing movie releases to this method. Also, the geometry of the theater and screen are more amenable to inclusion within a newly constructed but otherwise conventional multiple theater complex than is the dome style theater.

Multiple cameras and projectors

One wide screen development during the 1950's used non-anamorphic projection, but used three side by side synchronised projectors. Called Cinerama, the images were projected onto an extremely wide, curved screen. Some seams were said to be visible between the images but the almost complete filling of the visual field made up for this. This showed some commercial success as a limited location (only in major cities) exhibition of the technology in This is Cinerama, but the only memorable story-telling film of two made for this technology was How the West Was Won, widely seen only in its Cinemascope re-release.

While neither a technical nor a commercial success, the business model survives as implemented by the documentary production, limited release locations, and long running exhibitions of IMAX® dome movies.

Three-dimensional

For techniques used to display pictures with a three-dimensional appearance, see the 3-D film article for some movie history and the stereoscopy article for technical information.

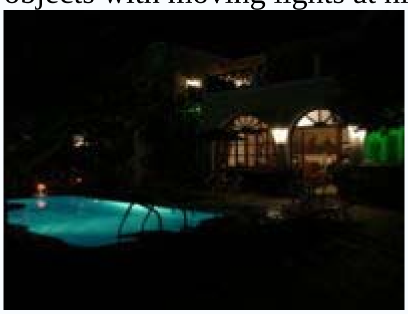
Shutter speed

Shutter speed can have a dramatic impact on the appearance of moving objects. Changes in background blurring are apparent from the need to adjust the aperture size to achieve proper exposure.

The shutter speed dial of a Fujica STX-1.

Slow shutter speed combined with panning the camera can achieve a motion blur for moving objects.

Using long shutter speeds can be used to achieve interesting effects for photographing objects with moving lights at night.



A photo at night with automatic exposure time 1/8 second

The same photo as above taken with exposure time 10 seconds

A photo of dark street at night (exposure time 20 seconds)

In photography, **shutter speed** is the time for which the shutter is held open during the taking of a photograph to allow light to reach the film or imaging sensor (in a digital camera).

In combination with variation of the lens aperture, and film/sensor sensitivity, this regulates how much light the camera will record. For a given exposure, a fast shutter speed demands a larger aperture to avoid under-exposure, just as a slow shutter speed is offset by a very small aperture to avoid over-exposure. Long shutter speeds are often used in low light conditions, such as at night.

Shutter speed is measured in seconds. A typical shutter speed for photographs taken in sunlight is 1/125th of a second. In addition to its effect on exposure, shutter speed changes the way movement appears in the picture. Very short shutter speeds are used to freeze fast-moving subjects, for example at sporting events. Very long shutter speeds are used to intentionally blur a moving subject for artistic effect.

In early days of photography, available shutter speeds were somewhat *ad hoc*. Following the adoption of a standardized way of representing aperture so that each major aperture interval exactly doubled or halved the amount of light entering the camera f/2.8, f/4, f/5.6, f/8, f/11, f/16 etc.), a standardized 2:1 scale was adopted for shutter speed so that opening one aperture stop and reducing the shutter speed by one step resulted in the identical exposure. The agreed standard for shutter speeds is:

- 1/8000 s
- 1/4000 s
- 1/2000 s
- 1/1000 s
- 1/500 s
- 1/250 s
- 1/125 s
- 1/60 s
- 1/30 s
- 1/15 s
- 1/8 s
- 1/4 s
- 1/2 s
- 1 s
- **B** (for *bulb*) — keep the shutter open as long as the release lever is engaged.
- **T** — keep the shutter open until the lever is pressed again.

This scale can be extended at either end in specialist cameras. Some older cameras use the 2:1 ratio at slightly different values, such as 1/100 s and 1/50 s, although mechanical shutter mechanisms were rarely precise enough for the difference to have any significance.

The term "speed" is improperly used, except if we speak of the inverse of the "exposure time". "Exposure time" is measured in seconds and "shutter speed" in terms of the inverse of a second, which is an appropriate measure of “speed”. So we would have the following "speed" measures:

- 8000 s^{-1}
- 4000 s^{-1}
- 2000 s^{-1}
- 1000 s^{-1}
- 500 s^{-1}
- 250 s^{-1}
- 125 s^{-1}
- 60 s^{-1}
- 30 s^{-1}
- 15 s^{-1}
- 8 s^{-1}
- 4 s^{-1}
- 2 s^{-1}
- 1 s^{-1}

The ability of the photographer to take images without noticeable blurring by camera movement is an important parameter in the choice of slowest possible shutter speed for a handheld camera. The rough guide used by most 35 mm photographers is that the slowest possible shutter speed that can be used with care is the shutter speed numerically closest to the lens focal length. For example, for handheld use of a 35 mm camera with a 50 mm normal lens, the closest shutter speed is 1/60 s. This rule can be augmented with knowledge of the intended application for the photograph, an image intended for significant enlargement and closeup viewing would require faster shutter speeds to avoid obvious blur. Through practice and special techniques such as bracing the camera, arms, or body to minimize camera movement longer shutter speeds can be used without blur. If a shutter speed is too slow for hand holding, a camera support — usually a tripod — must be used. There are also stabilized lenses available.

Cinematographic Shutter Formulae

In cinematography, shutter speed is a function of the frame rate and shutter angle. Most motion picture film cameras use a rotating shutter with a shutter angle of 170 to 180°, which leaves the film exposed for about 1/48 or 1/50 second at a standard 24 frame/s.

Where E = Exposure, F = Frames per second, and S = Shutter opening:

$$E = \frac{F \cdot 360^\circ}{S}$$

$$S = \frac{F \cdot 360^\circ}{E}$$

Cinematography

Cinematography, English render of the French "*cinématographie*", is the discipline of making lighting and camera choices when recording photographic images for the cinema. Etymologically, it means "writing in the movement", from the Greek words "*kinema*" meaning movement and "*graphein*", meaning writing. Put together you get *cinématographe*, the name of the camera invented by Léon Bouly in 1892.[*citation needed*] It is closely related to the art of still photography, though many additional issues arise when both the camera and elements of the scene may be in motion.

History

Roundhay Garden Scene directed by the world's first filmmaker, Louis Le Prince, in 1888.

The first attempt at cinematography can be tracked back to the world's first motion picture film, *Roundhay Garden Scene* featuring dancers.[*citation needed*] It was a sequence directed by Louis Le Prince, French inventor and showman, on October 14 1888 in Leeds, Yorkshire.[*citation needed*] This groundbreaking event happened seven years before the Lumière Brothers' *Sortie de l'usine Lumière à Lyon* became the world's first commercial exploitation of cinematography, in Paris, France.[*citation needed*] The European city soon became the motion picture capital of the world.

Cinematography is an art form unique to motion pictures. Although the exposing of images on light-sensitive elements dates back to the early 1800s[*citation needed*], motion pictures demanded a new form of photography and new aesthetic techniques.

In the infancy of motion pictures, the cinematographer was usually also the director and the person physically handling the camera. As the art form and technology evolved, a

separation between director and camera operator emerged. With the advent of artificial lighting and faster (more light sensitive) film stocks, in addition to technological advancements in optics and various techniques such as color film and widescreen, the technical aspects of cinematography necessitated a specialist in that area.

In 1919, in Hollywood, the new motion picture capital of the world, one of the first (and still existing) trade societies was formed: the American Society of Cinematographers (ASC), which stood to recognize the cinematographer's contribution to the art and science of motion picture making. Similar trade associations have been established in other countries, too.

The ASC defines cinematography as:

> a creative and intrepretive process that culminates in the authorship of an original work of art rather than the simple recording of a physical event. Cinematography is not a subcategory of photography. Rather, photography is but one craft that the cinematographer uses in addition to other physical, organizational, managerial, intrepretive and image-manipulating techniques to effect one coherent process. [1]

Aspects of cinematography

Numerous aspects contribute to the art of cinematography.

Film stock

Cinematography begins with rolls of film. Advancements in film emulsion and grain structure have led to a wide range of film stocks available to cinematographers. The selection of a film stock is one of the first decisions they must make during any film production.

Aside from the film gauge selection — 8 mm (amateur), 16 mm (semi-professional), 35 mm (professional) and 65 mm (epic photography, rarely used except in special event venues) — the cinematographer has a selection of stocks in reversal (which, when developed, create a positive image) and negative formats along with a wide range of film speeds (varying sensitivity to light) from ISO 50 (slow, least sensitive to light) to 800 (very fast, extremely sensitive to light) and differing response to color (low saturation, high saturation) and contrast (varying levels between pure black (no exposure) and pure white (complete overexposure)).

Advancements and adjustments to nearly all gauges of film created the "super" variety wherein the area of the film used to capture a single frame of an image is expanded, although the physical gauge of the film remains the same. Super 8 mm, Super 16 mm and Super 35 mm are all formats that utilize more of the overall film area for the image than their "regular" non-super counterparts.

The larger the film gauge, the higher the overall image resolution clarity and technical quality.

In the realm of digital imaging, various film stocks are no longer applicable, but the cameras themselves feature image adjustment capabilities that go far beyond the abilities of one particular film stock. The cameras can be adjusted to capture more or less color sensitivity, more or less image contrast, be more or less sensitive to light and so forth. One camera can achieve all the various looks of different emulsions, although it is heavily argued as to which method of capturing an image is the "best" method. It should be mentioned that the digital method of image adjustments (ISO, contrast etc) are executed by estimating the same adjustments that would take place if actual film were in use and are thus vunerable to the cameras sensor designers perceptions of various film stocks and image adjustment parameters. Many professionals consider this approach inferior or 'faking it'.

The lab

Laboratory work can also offer a considerable variance in the image produced. By controlling the temperature and varying the duration in which the film is soaked in the development chemicals and by skipping certain chemical processes (or partially skipping them), cinematographers can achieve very different looks from a single film stock in the laboratory.

Filters

Filters, such as diffusion filters or color-effect filters, are also widely used to enhance mood or dramatic effects. Most photographic filters are made up of two pieces of optical glass glued together with some form of image or light manipulation material between the glass. In the case of color filters, there is often a translucent color medium pressed between two planes of optical glass. Color filters work by blocking out certain color wavelengths of light from reaching the film. With color film, this works very intuitively

wherein a blue filter will cut down on the passage of red, orange and yellow light and create a blue tint on the film. In black and white photography, color filters are used somewhat counter intuitively; for instance a yellow filter, which cuts down on blue wavelengths of light, can be used to darken a daylight sky (by eliminating blue light from hitting the film, thus greatly underexposing the mostly blue sky), while not biasing most human flesh tone. Certain cinematographers, such as Christopher Doyle, are well known for their innovative use of filters. Filters can be used in front of the lens or, in some cases, behind the lens for different effects.

Lens

Focal length

The camera does what a human eye does. That is, it creates perspective and spatial relations with the rest of the world. However, unlike one's eye, a cinematographer can select different lenses for different purposes. Variation in focal length is one of the chief benefits of such an advantage. Cinematographers can choose between a range of wide angle lenses, "normal" lenses and telephoto lenses, as well as macro lenses and other special effect lens systems such as borescope lenses. Wide-angle lenses have short focal lengths and make spatial distances more obvious. A person in the distance is shown as much smaller while someone in the front will loom large. On the other hand, telephoto lenses reduce such exaggerations, depicting far-off objects as seemingly close together and flattening perspective. A Zoom lens allows a camera operator to change their focal length within a shot or quickly between setups for shots. As prime lenses offer greater optical quality and are "faster" (larger aperture openings, usable in less light) than zoom lenses, they are often employed in professional cinematography over zoom lenses. Certain scenes or even types of filmmaking, however, may require the use of zooms for speed or ease of use, as well as shots involving a zoom move.

Depth of field and focus

Focal length also affects the depth of field of a scene — that is, how much the background, mid-ground and foreground will be rendered in "acceptable focus" (only one exact plane of the image is in precise focus) on the film or video target. Depth of field (not to be confused with depth of focus) is determed by the aperture size and the focal distance. A large or deep depth of field is generated with a very small iris aperture and focusing on a point in the distance, whereas a shallow depth of field will be achieved

with a large (open) iris aperture and focusing closer to the lens. Depth of field is also governed by the format size. 70 mm film has the least depth of field for the same focal length lens than does 35 mm. 16 mm has even more and most digital video cameras have more depth of field than 16 mm. As videographers try to emulate the look of 35 mm film with digital cameras, this is one issue of frustration - excessive depth of field with digital cameras and using additional optical devices to reduce that depth of field.

In *Citizen Kane*, cinematographer Gregg Toland used tighter apertures to create very large depth of field in the scenes, often rendering every detail of the foreground and background of the sets in sharp focus. This practice is known as deep focus. Deep focus became a popular cinematographic device from the 1940s onwards in Hollywood. Today, the trend is for more shallow focus.

To change the plane of focus from one object or character to another within a shot is commonly known as a *rack focus*.

Aspect ratio and framing

Aspect ratio

The aspect ratio of an image is the ratio of its width to its height. Beginning in the 1910s, motion pictures settled on a ratio of four to three (four units wide to three units high). Often written as 4:3, this ratio may be reduced to 1.33:1 and this aspect ratio is commonly known as 1.33. The introduction of sound-on-film narrowed the aspect ratio briefly, before the Academy ratio of 1.37 was introduced in 1932 by means of thickening the frame line. For years, cinematographers were limited to this shape of image, but in the 1950s, thanks to the unanticipated popularity of Cinerama, widescreen ratios were introduced in an effort to pull audiences back into the theater and away from their home television sets. These new widescreen aspect ratios granted cinematographers a wider frame within which to compose their images. Many different proprietary photographic systems were invented and utilized in the 1950s to create widescreen movies, but one dominates today: the anamorphic process, which optically squeezes the image to photograph twice the horizontal area to the same size vertical as standard "spherical" lenses. The first commonly used anamorphic widescreen format was CinemaScope, which used a 2.35:1 aspect ratio, although it was originally 2.55:1. CinemaScope was used from 1953 to 1967, but due to technical flaws in the design and its ownership by Fox, several third-party companies, led by Panavision's technical improvements in the

1950s, now dominate the anamorphic cine lens market. Changes to SMPTE projection standards altered the projected ratio from 2.35:1 to 2.39:1 in 1970, although this did not change anything regarding the photographic anamorphic standards; all changes in respect to the aspect ratio of anamorphic 35 mm photography are specifically correlative to camera or projector gate sizes, not the optical system.

After the "widescreen wars" of the 1950's, the motion-picture industry settled into 1.85:1 (which is a cropped version of 1.37:1) as a standard for theatrical projection in the United States and the United Kingdom. Europe and Asia opted for 1.66:1 at first, although 1.85:1 has largely permeated these markets in recent decades. Certain "epic" or adventure movies utilized the anamorphic 2.39:1.

In the 1990's, with the advent of high-definition video, television engineers created the 1.78:1 (16:9) ratio as a mathematical compromise between the theatrical standard of 1.85:1 and television's 1.33:1, as it was not physically possible to safely create a television tube with a width of 1.85:1. Until that point, nothing had ever been originated in 1.78:1. Today, this is a standard for high-definition video and for widescreen television.

Lighting

Most likely the single most important aspect of cinematography is lighting. Light is necessary to create an image exposure on a frame of film or on a digital target (CCD, etc). The art of lighting for cinematography goes far beyond basic exposure, however, into the essence of visual storytelling. Lighting contributes considerably to the emotional response an audience has watching a motion picture. The control of light quality, color, direction and intensity is a major factor in the art and science of cinematography.

Camera movement

One aspect of cinematography that strongly separates it from still photography is the ability to move the camera, which represents the audience's viewpoint or perspective, during the course of filming. This movement plays a considerable role in the emotional language of film images and the audience's emotional reaction to the action on the screen. From the most basic movements of panning (horizontal shift in viewpoint from a fixed position; like turning your head side-to-side) and tilting (vertical shift in viewpoint from a fixed position; like tipping your head back to look at the sky or dropping your head down

to look at the ground) to dollying (placing the camera on a moving platform to shift it from one location to another on a horizontal plane) and craning (moving the camera in a vertical position; being able to lift it off the ground as well as swing it side-to-side from a fixed base postion) and a combination of all of the above.

Cameras have been mounted to nearly every imaginable form of transportation.

Most cameras can also be handheld, that is the camera operator literally holds the camera in their hands and moves from one position to another while filming the action. Personal stabilizing platforms came into being in the late 1970s through the invention of Garret Brown, which became known as the Steadicam. The Steadicam is a body harness and stabilization arm that connects to the camera that allows the operator to move naturally while completely isolating the movements of their body from the movements of the camera. After the Steadicam patent expired in the early 1990s, many other companies began manufacturing their concept of the personal camera stabilizer.

Special effects

The first special effects in the cinema were created while the film was being shot. These came to be known as "in-camera" effects. Later, optical and digital effects were developed so that editors and visual effects artists could more tightly control the process by manipulating the film in post-production.

Frame rate selection

Motion picture images are presented to an audience at a constant speed. In the theater, it is 24 frames per second, in NTSC (US) Television, it is 30 frames per second (29.97 to be exact), in PAL (Europe) television it is 25 frames per second. This speed of presentation does not vary. However, by varying the speed at which the image is captured, various effects can be created knowing that the faster or slower recorded image will be played at a constant speed.

For instance, time-lapse photography is created by exposing an image at an extremely slow rate. If a cinematographer sets a camera to expose one frame every minute for four hours, and then that footage is projected at 24 frames per second, the event that took four fours to record will now take 10 seconds to present (1 frame per minute for 4 hours equals 240 frames, projected at 24 frames per second equals 10 seconds). This

compresses the event that took place in four hours into just 10 seconds. At this speed, one can present the events of a whole day (24 hours) in just one minute. The inverse of this, if an image is captured at speeds above that at which they will be presented, the effect is to greatly slow down (slow motion) the image. If a cinematographer shoots a person diving into a pool at 96 frames per second, and that image is presented back at 24 frames per second, it will take 4 times as long to watch the dive as it did for it to actually happen.

In motion pictures the manipulation of time and space is a considerable contributing factor to the narrative storytelling tools. Film editing plays a much stronger role in this manipulation, but frame rate selection in the photography of the original action is also a contributing factor to altering time.

Role of the cinematographer

In the film industry, the **cinematographer** is responsible for the technical aspects of the images (lighting, lens choices, composition, exposure, filtration, film selection), but works closely with the director to ensure that the artistic aesthetics are supporting the director's vision of the story being told. The cinematographers are the heads of the camera, grip and lighting crew on a set, and for this reason they are often called **directors of photography** or **DP's**.

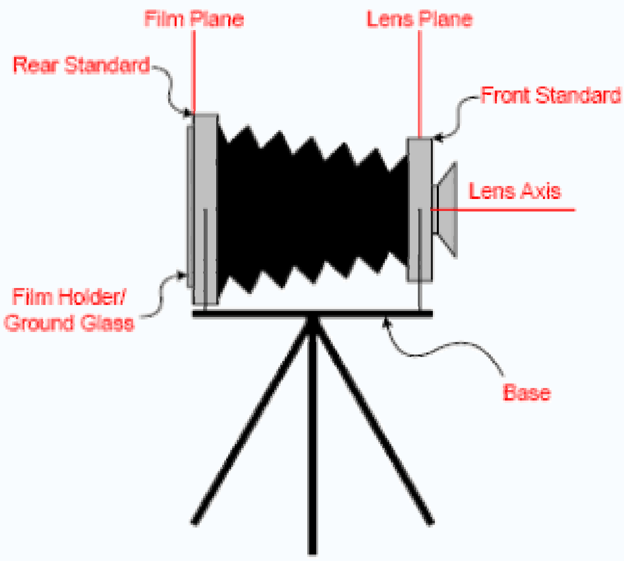
Directors of photography make many creative and interpretive decisions during the course of their work, from pre-production to post-production, all of which affect the overall feel and look of the motion picture. Many of these decisions are similar to what a photographer needs to note when taking a picture: the cinematographer controls the film choice itself (from a range of available stocks with varying sensitivities to light and color), the selection of lens focal lengths, aperture exposure and focus. Cinematography, however, has a temporal aspect (see persistence of vision), unlike still photography, which is purely a single still image. It is also bulkier and more strenuous to deal with movie cameras, and it involves a more complex array of choices. As such a cinematographer often needs to work co-operatively with more people than does a photographer, who could frequently function as a single person. As a result, the cinematographer's job also includes personnel management and logistical organization.

Evolution of technology: new definitions

Traditionally the term "cinematography" referred to working with motion-picture film emulsion, but it is now largely synonymous with videography and digital video due to the popularity of digital cinema.

Modern digital image processing has also made it possible to radically modify pictures from how they were originally captured. This has allowed new disciplines to encroach on some of the choices that were once the cinematographer's exclusive domain.

View camera



Basic View Camera Terminology

The **view camera** is a type of camera with a very long history (some modern examples are often mistaken for antiques), but they are still used today by professional and amateur photographers who want full control of their images. The view camera is basically a light-tight assembly composed of a flexible mid-section, or bellows, attached to a device that holds a film sheet, photo plate or digital imager at one end (the rear standard) and a similar one that holds the lens at the other end (the front standard). The front and rear standards are not fixed relative to each other (unlike most cameras). Movement of the front and rear standards allows the photographer to move the lens and film plane independently for precise control of the image's focus, depth of field and perspective.

View camera operation

To operate the view camera, the photographer opens the shutter on the lens to focus and compose the image on a ground glass plate on the rear standard. The ground glass is held in the same plane that the film will later occupy, so that an image that is well focussed on the ground glass will be well focussed on the film. The ground glass image is somewhat dim and can be difficult to view in bright light. The photographer will often use a "dark cloth" over his or her head, and the rear of the camera. The darkcloth shrouds the viewing area and keeps environmental light from obscuring the image. In the dark space created

by the dark cloth, the image appears as bright as it can and allows the image to be most easily viewed, assisting in focussing and composition.

Often a photographer will use a magnifying lens, usually a high quality loupe, to critically focus the image. An addition over the ground glass called a Fresnel lens can considerably brighten the ground glass image (albeit with a slight loss of focusing accuracy). The taking lens may be stopped down to help gauge depth of field effects and vignetting, but while the image is being composed the lens is generally opened to its widest setting to aid in focussing.

The ground glass and ground glass frame assembly, known as the spring back, is held in place by springs that pull and hold the ground glass firmly into the plane of focus during the focussing and composing process. Once the focussing process is complete, the same springs act as a flexible clamping mechanism to press the film holder into the same plane of focus the ground glass occupied.

To take the photograph the ground glass is pulled back and the film holder is slid into its place. The spring back keeps the film holder firmly in place.

The shutter is then closed and cocked, the shutter speed and aperture set, and the darkslide of the film holder removed, revealing the sheet of film. The shutter is then triggered, the exposure made, and the darkslide replaced into the film holder.

Sheet film holders are generally interchangeable between the various brands and models of view camera, in the most common formats, adhering to a set of standards. The largest cameras and more uncommon formats are less standardized.

There are special film holders and accessories that fit in place of a standard film holder, such as Grafmatic, which could fit six sheets of film in the space of an ordinary two-sheet holder, and some light meters have an attachment that inserts into the film holder slot on the camera back that allows the photographer to measure light falling at a specific point on the film plane. The entire film holder/back assembly is often an industry standard Graflex back, removable so accessories like roll-film holders and digital imagers can be used without altering focus.

Types of view camera

Generally, view cameras are built for sheet film, one exposure for each sheet. These can be quite large, and are typically standardized to the following large film formats (measurements in inches): 4x5, 5x7, 4x10, 5x12, 8x10, 11x14, 7x17, 8x20, 12x20, 20x24, and 30x40. In Europe and Asia, the long side is often listed first when discussing sheet film size and the associated view camera equipment, albeit in inches rather than a metric measurement, ie. a 5x4 camera is identical to a 4x5 camera. Sometimes the closest equivalent in centimeters is used as well, ie. 9x12 or 12x9 for 4x5.

Far and away the most popular formats are 4x5 and 8x10, with the majority of cameras and lenses designed for one or the other.

There are several varieties of view camera, engineered for different purposes and allowing different degrees of movement and portability. They include:

- Monorail Camera - This is the most common type of studio view camera, with the front and rear standards being mounted to a single rail that is fixed to a camera support. This design allows the greatest range of movements and flexibility, with both front and rear standards able to tilt, shift, rise, fall and swing in similar proportion. These are generally made of metal with leather or synthetic bellows, and are difficult to pack for travel. Sinar and Toyo are popular manufacturers of monorail view camera systems. ARCA-Swiss produces monorail cameras for field use in addition to models for the more conventional studio applications. Many manufacturers also offer monorail extensions, which permit the front or rear standards to move further away from each other, allowing for focus on very close objects (macrophotography).
- Field Camera - These have the front and rear standard mounted to sliding rails on a flat bed that is fixed to a camera support. These cameras are designed to fold up into a small box for portability, and can be made of wood as well as composites like carbon fiber. The trade off is that the standards are not as mobile or as adjustable as with a monorail design, especially the rear standard, which may even be fixed and offer no movement. Their light weight and ease of packing and set-up are popular with landscape photographers. Extremely large cameras of this type, using 11x14 film and larger, or panoramic film sizes such as 4x10 or 8x20, are sometimes referred to as Banquet Cameras. Such cameras were once used to photograph large, posed groups of people to mark an occasion, such as those attending a banquet. Studio and Salon Cameras are similar in construction, but do not fold up for portability. Wisner and Tachihara are popular examples of modern Field Cameras at either end of the price spectrum.
- Press and Technical Cameras - These are very portable, but often have the least amount of usable movement of the three main types of view camera. Originally made for news photographers before roll film became popular, they are designed to fold up, with the lensboard in place, in less than a second. Some are equipped with rangefinders and viewfinders for hand-held work. The most recent have a

central shutter with flash synchronization, some antique models have only a focal plane shutters. Many have two shutters, allowing fast shutter speeds and the use of non-shuttered lenses with the focal plane shutter and electronic flash synchronization at any speed with in-lens the central shutter. These are typically made of machined and stamped metal, designed for daily use by working newsmen, so they are usually very robust, but also very heavy. The Speed Graphic in its many incarnations was the camera of choice for the American photojournalist in the Golden Age of Hollywood and in the Second World War, and used examples are still popular with photography students. Modern examples of Technical and Press View Cameras are still in production by Horseman, Wista and Linhof.

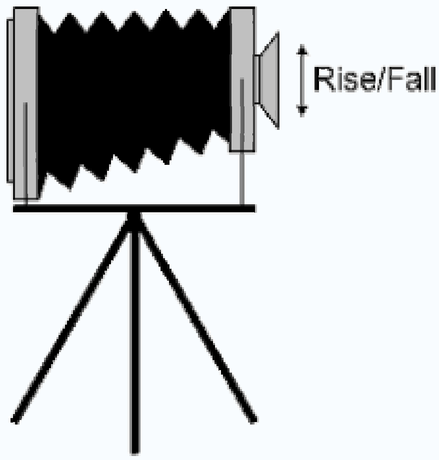
View camera movements

Photographers use view cameras to control **focus** and **convergence** of parallel lines. Image control is done by moving the front and/or rear standards. Movements are the ways the front and rear standards can be positioned to alter perspective and focus. The term can also refer to the mechanisms on the standards that allow the position to be achieved.

Not all cameras have all movements available to both the front and rear standards, and some cameras have more movements available than others. In addition, some cameras are designed with mechanisms that make intricate movement combinations easier for the photographer to accomplish.

Some limited view camera-type movements are possible with SLR cameras using various perspective control lenses.

Rise and fall



Front Standard Rise

Rise and fall are the movements of either the front or rear standard vertically along a line in a plane parallel to the film plane. Rise is a very important movement especially in architectural photography. Generally, the lens is moved vertically—either up or down—along the lens plane in order to change the portion of the image that will be captured on the film.

The main effect of rise is to eliminate the optical illusion that tall buildings are "falling over backwards." One way to get the image of a tall building to appear on the film is to point the camera upwards. This causes the top of the building to be optically further away than the bottom of the building. Objects further away tend to appear smaller than do objects that are near by. This phenomenon is called convergence. If we assume the two sides of the building are parallel to each other, then, like railroad tracks, the sides of the building will converge at the top. This effect is captured on film to give the appearance that the top of the building is smaller than the bottom of the building. The building will appear on film as though it were tipping over backwards.

To correct the convergence of parallel lines, the film plane must be kept parallel to the face of the building. This usually means the film plane is vertical. Unless the camera has a wide angle lens attached, some of the building will not be captured on film. Of course, the use of a wide angle lens is one way to keep the film plane vertical and still capture the entire height of the building but a lot of foreground will also be captured. Another method, the one available on large format cameras, is to raise the lens. Generally, the lens produces a larger image circle than the film can record. This is especially true of most large format lenses. By moving the lens up, the image is effectively moved down such that the top of the building can be captured on the film. In Figure a) below, the lens is in

the “normal” position. Notice how much of the image is wasted. In Figure b), the lens has been shifted up. The top of the building, at the sacrifice of the green ground, is now inside the area captured on film.

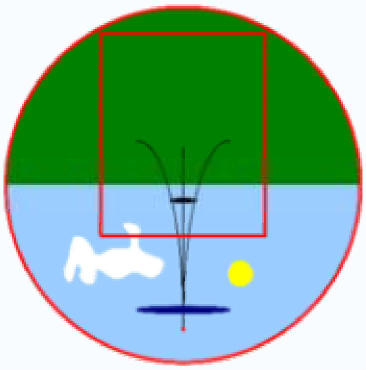


Figure a) No Rise

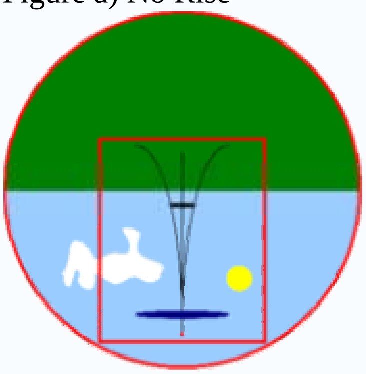
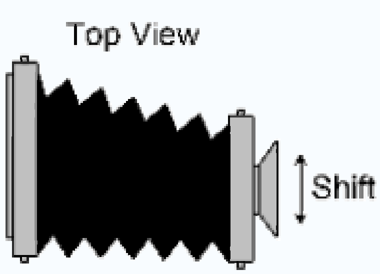


Figure b) After Rise

Shift

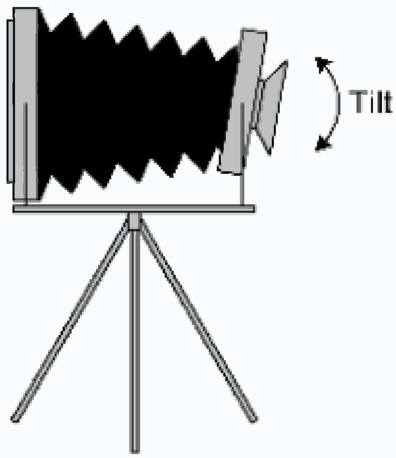


Front Standard Shift

Moving the standard left or right in relation to the film plane is called lens shift or simply shift. This movement is similar to the rise and fall movements but affects the image in the

horizontal axis instead of the vertical axis. A possible use for shift is to remove the image of the camera from the final image when photographing directly into a mirrored surface.

Tilt



Front Standard Tilt

Altering the angle of the lens in relation to the film plane by tilting the lens standard back and forth is called lens tilt or just tilt. Tilt is another important movement and is especially useful in landscape photography. By using the Scheimpflug principle, the “plane of sharp focus” can be changed so that any plane can be brought into sharp focus. When the film plane and lens plane are parallel as is the case for most 35mm cameras, the plane of sharp focus will also be parallel to these two planes. If, however, the lens plane is tilted with respect to the film plane, the plane of sharp focus will also be tilted according to geometrical and optical properties. The three planes will intersect in a line below the camera for downward lens tilt. The tilted plane of sharp focus is very useful in that this plane can be made to coincide with a near and far object. Thus, both near and far objects on the plane will be in focus.

This effect is often incorrectly thought of as increasing the depth of field. Depth of field is a function of the focal length, aperture, and image distance. As long the photographer wants sharpness in a plane that is parallel to the film, tilt is of no use. However, tilt has a strong effect on the depth of field by drastically altering its shape, making it asymmetrical. Without tilt, the limits of near and far acceptable focus are parallel to the plane of sharp focus as well as parallel to the film. With forward tilt, the plane of sharp focus tilts even more and the near and far limits of acceptable focus form a wedge shape

(viewed from the side). Thus, the lens still sees a cone shaped portion of whatever is in front of it while the wedge of acceptable focus is now more closely aligned with this cone. Therefore, depending on the shape of the subject, a wider aperture can be used, lessening concerns about camera stability due to slow shutter speed and diffraction due to too-small aperture.

Group f/64, the loose association of “West Coast” photographers such as Ansel Adams and Imogen Cunningham, must have selected their name with a certain amount of hyperbole in mind. They were not specifying that aperture as a silver bullet.

The purpose of tilting is to achieve the desired depth of field using the optimal possible aperture. Using a needlessly small aperture risks losing to diffraction and camera or subject motion what one gains from depth of field. Only testing a given scene, or experience, will show whether tilting is better than leaving the standards neutral and relying on the aperture alone to achieve the desired depth of field. If the scene is sharp enough at f/32 with 2 degrees of tilt but would need f/64 with zero tilt, then tilt is the solution. If another scene would need f/45 with or without tilt, then nothing is gained.

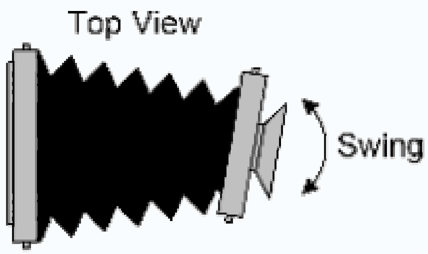
With a forward tilt, the shape of the portion of a scene in acceptable focus is a wedge. Thus, the scene most likely to benefit from tilting is short in the front and expands to a greater height or thickness toward the horizon. A scene consisting of tall trees in the near, middle and far distance may not lend itself to tilting unless the photographer is willing to sacrifice either the top of the near trees and/or the bottom of the far trees.

Assuming lens axis front tilt, here are the trade offs in choosing between a small degree of tilt (say less than 3) and a larger tilt: A small tilt causes a wider or fatter wedge but one that is far off axis from the cone of light seen by the lens. Conversely, a large tilt (say 10 degrees) causes the wedge to be more aligned with the view of the lens but with a narrower wedge. Thus, a modest tilt is often, or even usually, the best starting point. See *Focusing the View Camera* by Harold Merklinger.

Small and medium format cameras have fixed bodies that do not allow for misalignment of the film and lens planes, intentionally or not. Tilt and shift lenses can be purchased from a number of lens makers that allow these cameras to have a small amount of adjustment, mostly rise and fall. High quality tilt/shift lenses are quite expensive. For the price of a new Nikon tilt/shift lens, one can purchase a good quality used large format

camera that offers much more range of adjustment.

Swing



Front Standard Swing

Altering the angle of the lens standard in relation to the film plane by swiveling it from side to side is called swing. Swing is similar to Tilt but in the horizontal axis. Swing may be used to achieve sharp focus along the entire length of a picket fence, for example.

Back Tilt/Swing

Angular movements of the rear standard change the angle between the lens plane and the film plane just as front standard angular movements do. Although rear standard tilt will change the plane of sharp focus in the same manner as front standard tilt does, this is not usually the reason rear tilt/swing is used. When a lens is a certain distance (its focal length) away from the film, distant objects such as faraway mountains are in focus. Moving the lens farther from the film brings closer objects into focus. Tilting or swinging the film plane puts one side of the film farther from the lens than the center is and the opposite point of the film is therefore closer to the lens.

One reason to swing or tilt the rear standard is to keep the film plane parallel to the face of the object being photographed. Another reason to swing or tilt the rear standard is to control convergence and, hence, perspective. By swinging the rear standard, perspective can be changed by making more distant objects appear closer, for example.

View camera lenses

A view camera lens typically consists of:

- A front lens element, sometimes referred to as a cell.

- A shutter, which consists of an electronic or spring-actuated iris which controls exposure duration. (On early lenses, air-actuated shutters were sometimes used, and others had no moving shutter at all, a simple lens cap was used instead.)
- The aperture diaphragm
- A lensboard
- A rear lens element (or cell).

Almost any lens of the appropriate coverage area may be used with almost any view camera. All that is required is that the lens be mounted on a lensboard compatible with the camera. A lensboard is simply a flat board, typically square in shape and made of either metal or wood, designed to lock securely into the front standard of a particular view camera, typically engineered for quick removal and replacement for swapping lenses in the field. Not all lensboards work with all models of view camera, though some cameras may be designed to work with a common lensboard type. Lensboards usually come with a hole sized according to the shutter size, often called the Copal Number. Copal is the most popular maker of leaf shutters for view camera lenses. The following is a list of the Copal Number and the corresponding diameter required in the lensboard to mount the shutter:

- Copal #0 - 34.6 mm
- Copal #1 - 41.6 mm
- Copal #3 - 65 mm
- Copal #3s - 64.5 mm

The lens is designed to split into two pieces, the front and rear elements mounting to the shutter and lensboard. This is usually done by a trained technician, but mechanically inclined photographers often do this themselves.

View camera lenses are designed with both focal length and coverage in mind - a 300mm lens may give a different angle of view (either over 31° or over 57°) depending on whether it was designed to cover a 4x5 or 8x10 image area. Most lenses are designed to cover more than just the image area to allow for "movement" - positioning the front or rear standards out of linear alignment for perspective and focussing closer than infinity without vignetting.

Focusing involves moving the front standard closer to or further away from the rear standard, the lens itself does not have nor need any internal helical focusing device. The lens elements do not need to move in relation to one another.

Very long focus lenses or very short wide-angle lenses may require the camera be fitted with special bellows to bring the subject into proper focus, as the regular bellows will be either unable to extend far enough to accommodate long lenses, or collapse tight enough for extremely short ones. "Bag bellows" are common wide-angle photography accessories, replacing the accordion-folded bellows with a simple light-tight leather or synthetic bag. Recessed lensboards are also sometimes used to get the rear element of a wide angle lens close enough to the film plane to achieve focus. Some cameras offer extra-long rails and bellows to mount the standards to for long lens work.

Zoom lenses are unheard of in view camera photography, but there are "convertible" lenses that allow the photographer to add and remove lens elements in the field to alter the optical formula, resulting in a new focal length. These are popular with field photographers who would prefer to save weight by carrying one convertible lens rather than two or three regular lenses. The trade off is a smaller maximum aperture than is usual with regular lenses, and sometimes convertible lenses are not corrected for chromatic aberration, making them useless with color film.

Soft focus lenses introduce spherical aberration deliberately into the optical formula for a pleasing ethereal effect. The amount of soft-focus effect is determined by either aperture size or special disks that fit into the lens to modify the aperture shape. Some antique lenses have a lever which controls the softening effect by altering the optical formula on the fly, similar to modern SLR soft focus lenses.

Current large format lens manufacturers:

- Schneider Kreuznach - Price-no-object high quality lenses.
- Nikon - Noted for its high quality telephoto designs. As of January 2006, Nikon announced it would discontinue manufacturing its LF lenses.
- Rodenstock - Extremely high quality, reasonably priced.
- Fujinon - Has a strong presence in Asia.
- Cooke - Interesting and expensive soft focus and color-corrected convertible lenses.
- Congo - Budget lenses, but offering interesting soft focus and telephoto designs.
- Seagull/Shen-Hao/Sinotar - Budget lenses.
- Wisner - Offer a modern convertible Plasmat set.
- Sinar - Rebranded Rodenstock lenses.
- Caltar - Rebranded Rodenstock lenses.
- Linhof - Rebranded Rodenstock and Schneider lenses.

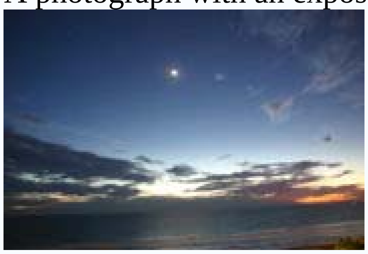
View Camera Film

View cameras use sheet film but can use roll film (generally 120 size) by using special roll film holders. Popular image formats for the 4x5 camera are 6x6, 6x7, 6x9, 6x12, and 6x17cm. 6x12 and 6x17cm are suited to panoramic photography.

Without modifying the camera (but with an inexpensive modification of the darkslide), a photographer can expose a half sheet of film at a time. While this could be useful for saving money, it's almost always instead a means of changing the format so that, for example, a 4x5 camera can take two 2x5 panoramic photos, an 8x10 can take two 4x10s etc. This is popular for landscape imagery, and in the past was common at banquets and similar functions.

Exposure (photography)

A photograph with an exposure time of 25 seconds



A photograph of a night-time sky with an exposure time of 8 seconds.

In photography, **exposure** is the total amount of light allowed to fall on the photographic medium (photographic film or image sensor) during the process of taking a photograph. Exposure is measured in exposure value (EVs), with higher values denoting more light.

The "correct" exposure for a photograph is determined by the sensitivity of the medium used. For photographic film, sensitivity is referred to as film speed and is measured on a scale published by the International Organization for Standardization (ISO). Faster film requires less exposure and has a higher ISO rating. Exposure is a combination of the length of time and the level of illumination received by the photosensitive material. Exposure time is controlled in a camera by shutter speed and the illumination level by the lens aperture. Slower (longer) shutter speeds and greater (bigger) lens apertures produce greater exposures. The electronics in a digital camera may allow one to adjust the sensitivity of the CCD or CMOS sensor. ISO numbers are usually used to express this attribute.

An approximately correct exposure will be obtained on a sunny day using ISO 100 film, an aperture of f/16 and a shutter speed of 1/125th of a second. This is called the sunny f/16 rule.

An important principle of exposure is reciprocity. If one exposes the film or sensor for a longer period, a reciprocally smaller aperture is required to reduce the amount of light hitting the film to obtain the same exposure. For example, the photographer may prefer to make his sunny-16 shot at an aperture of f/5.6 (to obtain a shallow depth of field). As f/5.6 is 3 **stop**s 'faster' than f/16, with each stop meaning double the amount of light, a new shutter speed of (1/125)/(2·2·2) = 1/1000 is needed. Once the photographer has determined the exposure, aperture stops can be traded for halvings or doublings of speed, within limits.

A demonstration of the effect of exposure in night photography. Longer shutter speeds mean increased exposure.

The true characteristic of most photographic emulsions is not actually linear, (see sensitometry) but it is close enough over the exposure range of about one second to 1/1000th of a second. Outside of this range, it becomes necessary to increase the exposure from the calculated value to account for this characteristic of the emulsion. This characteristic is known as *reciprocity failure*. The film manufacturer's data sheets should be consulted to arrive at the correction required as different emulsions have different characteristics.

The Zone System is another method of determining exposure and development combinations to achieve a greater tonality range over conventional methods by varying the contrast of the 'film' to fit the print contrast capability. Digital cameras can achieve similar results (High Dynamic Range) by combining several different exposures (varying only the shutter speeds) made in quick succession.

Today, most cameras automatically determine the correct exposure at the time of taking a photograph by using a built-in light meter, or multiple point meters interepreted by a built-in computer, see metering mode.

Blown out highlights

Example image exhibiting blown-out highlights. Top: original image, bottom: blown-out areas marked red

In a photo the areas where information is lost, due to extreme brightness is known as "Blown out highlights", or "Flared highlights". This information loss is irreversible most of the time, though small problems can be made less noticeable using photo manipulation software. The exception to this is when an image is captured using "RAW" on a digital camera. With the appropriate software, some clipping can be recovered.

Film tends to have better latitude to cope with the highlight range, compared to digital, with a more gradual transition/tonal curve. Smaller sensor digital cameras (compacts etc.), are also in general more prone to clipping, than larger sensor cameras.

Loss of highlights in a photograph are often undesirable, but in some cases can be considered to "enhance" appeal. Examples include black and white photography, and portraits, with an out of focus background.

Photojournalism

Sports photojournalists at Indianapolis Motor Speedway

Photojournalism is a particular form of journalism (the collecting, editing, and presenting of news material for publication or broadcast) that creates images in order to tell a news story. It is now usually understood to refer only to still images, and in some cases to video used in broadcast journalism. Photojournalism is distinguished from other close branches of photography (such as documentary photography, street photography or celebrity photography) by the qualities of:

- ***Timeliness* —** the images have meaning in the context of a published chronological record of events.
- ***Objectivity* —** the situation implied by the images is a fair and accurate representation of the events they depict.
- ***Narrative* —** the images combine with other news elements, to inform and give insight to the viewer or reader.

Photojournalists must make decisions instantly and carry photographic equipment under the same circumstances as those involved in the subject (fire, war, rioting)—often while being exposed to the same risks.

Photojournalism as a descriptive term often implies the use of a certain bluntness of style or approach to image-making. The photojournalist approach to candid photography is

becoming popular as a unique style of commercial photography. For example, many weddings today are shot in photojournalism style resulting in candid images that chronicle the events of the wedding day.

Etymology

The invention of the term *"photojournalism"* is commonly attributed to Cliff Edom (1907–1991), who taught at the University of Missouri School of Journalism for 29 years. Edom established the first photojournalism workshop there in 1946. Some attribute the word, instead, to the then-Dean of the School of Journalism, Frank L. Mott.

History

Foundations

The practice of illustrating news stories with photographs was made possible by printing and photography innovations that occurred between the years 1880 and 1897. While photographs were taken of newsworthy events as early as the 1850s, up until the 1880s, printed news stories were illustrated exclusively with wood engravings because only engravings were compatible with the printing presses of that time. Photographs had to be re-interpreted by an engraver before publication. The pioneering battlefield photographs from the Crimean War (1853 to 1856) by British press reporters such as William Simpson [1] of the *Illustrated London News*, or Roger Fenton [2] were published in this way. Similarly, the American Civil War photographs of Matthew Brady were engraved for publication in *Harper's Weekly*. Because the public craved more realistic representations of news stories, it was common for newsworthy photographs to be exhibited as originals or be copied photographically in limited numbers.

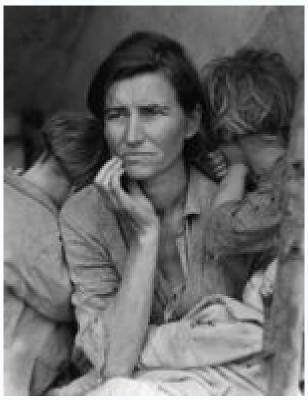
On March 4, 1880, *The Daily Graphic* (New York) [3] published the first halftone reproduction of a news photograph. In 1887, Flash powder was invented, enabling journalists such as Jacob Riis to photograph informal subjects indoors. By 1897, it became possible to reproduce halftone photographs on printing presses running at full-speed [4].

Despite these innovations, limitations remained, and many of the sensational newspaper and magazine stories in the period from 1897 to 1927 (*see* Yellow Journalism) were illustrated with engravings. In 1921, the wirephoto made it possible to transmit pictures

almost as quickly as news itself could travel. However, it was not until development of the commercial 35mm Leica camera in 1925, and the first flash bulbs between 1927 and 1930 that all the elements were in place for a "golden age" of photojournalism.

Golden Age

In the "golden age" of photojournalism (1930s–1950s), some magazines (*Picture Post* (London), *Paris Match* (Paris), *Life* (USA), *Sports Illustrated* (USA)) and newspapers (*The Daily Mirror* (London), *The Daily Graphic* (New York)) built their huge readerships and reputations largely on their use of photography, and photographers such as Robert Capa, Alfred Eisenstaedt, Margaret Bourke-White, W. Eugene Smith became well-known names.



In *Migrant Mother* Dorothea Lange produced the seminal image of the Great Depression. The FSA also employed several other photojournalists to document the depression.

Perhaps there was no rush to name the photographer, and the photographer was not eager to be named, because for years even the finest photographs given the most prominent display were poorly reproduced in the newspaper. Until the 1980s, most large newspapers were printed using turn-of-the-century “letterpress” printing technology using easily smudged oil-based ink, off-white, low-quality “newsprint” paper, and coarse engraving screens. The words stayed legible on the page, but the photoengraving dots that formed the pictures almost always smeared and became fuzzy and indistinct, so that even when newspapers used photographs well—a good crop, a respectable size—murky reproduction often left readers re-reading the caption to see what the photo was all about. Not until the 1980s had a majority of newspapers switched to “offset” presses that reproduce photos with fidelity on better, whiter paper.

By contrast *Life*, one of America's most popular weekly magazines from 1936 through the early 1970s, was filled with photographs reproduced beautifully on oversize 11x14-inch pages, using fine engraving screens, high-quality inks, and glossy paper. *Life* often published a UPI or AP photo that had been widely reproduced in newspapers, but the quality magazine version appeared to be a different photo altogether.

In large part because their pictures were clear enough to be appreciated, and because their name always appeared with their work, magazine photographers achieved near-celebrity status. *Life* became a standard by which the public judged photography, and many of today's photo books celebrate "photojournalism" as if it had been the exclusive province of near-celebrity magazine photographers.

The Best of Life (1973), for example, opens with a two-page (1960) group shot of 39 justly famous *Life* photographers. But 300 pages later, photo credits reveal that scores of the photos among *Life's* "best" were taken by anonymous UPI and AP photographers.

Farm Security Administration

From 1935 to 1942, the Farm Security Administration and its predecessor the Resettlement Administration were part of Franklin Roosevelt's New Deal, and were designed to address agricultural problems and rural poverty associated with the Great Depression. A special photographic section of the agency, headed by Roy Stryker, was intended merely to provide public relations for its programs, but instead produced what some consider one of the greatest collections of documentary photographs ever created in the U.S. Whether this effort can be called 'photojournalism' is debatable, since the FSA photographers had more time and resources to create their work than most photojournalists usually have.

World War II

World War II brought a tremendous increase in the supply and demand for quality photojournalism. In its latter stages, the war also stimulated the supply of new faster and smaller cameras from Japan to Europe and the USA.

Acceptance by the art world

Since the late 1970s, photojournalism and documentary photography have increasingly been accorded a place in art galleries alongside fine art photography. Luc Delahaye,

Lauren Greenfield and Chien-Chi Chang, to name a few among many, exhibit in galleries regularly.

Professional organizations

The Danish Union of Press Photographers (Pressefotografforbundet) was the first national organization for newspaper photographers in the world. It was founded in 1912 in Denmark by six press photographers in Copenhagen. Today it has nearly 800 members.

The National Press Photographers Association (NPPA) was founded in 1946 in the U.S., and has approximately 12,000 members. Others around the world include:

- British Press Photographers Association, 1984
- Hong Kong Press Photographers Association, 1989
- Northern Ireland Press Photographers Association, 2000
- Pressfotografernas Klubb Sweden, 1930
- PK — Pressefotografenes Klubb Norway

News organisations and journalism schools run many different awards for photojournalists. Since 1968, Pulitzer Prizes have been awarded for the following categories of photojournalism: 'Feature Photography', 'Spot News Photography' and 'Capture the Moment'. Other awards are World Press Photo, Best of Photojournalism and Pictures of the Year.

Photographers crowd around a starlet at the Cannes Film Festival.

Ethical and legal considerations

Photojournalism works within the same ethical approaches to objectivity that are applied by other journalists. What to shoot, how to frame and how to edit are constant considerations.

Often, ethical conflicts can be mitigated or enhanced by the actions of a sub-editor or picture editor, who takes control of the images once they have been delivered to the news organisation. The photojournalist often has no control as to how images are ultimately used.

The emergence of digital photography offers whole new realms of opportunity for the manipulation, reproduction, and transmission of images. It has inevitably complicated many of the ethical issues involved.

The U.S. National Press Photographers Association, and other professional organizations, maintain a Code of Ethics to address what are thought to be the proper approaches to these issues.

Major ethical issues are often inscribed with more or less success into law. Laws regarding photography can vary significantly from nation to nation. The legal situation is further complicated when one considers that photojournalism made in one country will often be published in many other countries.

The impact of new technologies

Smaller, lighter cameras greatly enhanced the role of the photojournalist. Since the 1960s, motor drives, electronic flash, auto-focus, better lenses and other camera enhancements have made picture taking easier. New digital cameras free photojournalists from the limitation of film roll length, as hundreds of images can be stored on a single microdrive or memory card.

Content remains the most important element of photojournalism, but the ability to extend deadlines with rapid gathering and editing of images has brought significant changes. As recently as 15 years ago, nearly 30 minutes were needed to scan and transmit a single color photograph from a remote location to a news office for printing. Now, equipped with a digital camera, a mobile phone and a laptop computer, a photojournalist can send a high-quality image in minutes, even seconds after an event occurs. Video phones and portable satellite links increasingly allow for the mobile transmission of images from almost any point on the earth.

There is some concern by news photographers that the profession of photojournalism as it is known today could change to such a degree that it is unrecognizable as image-

capturing technology naturally progresses. There is also concern that fewer print publications are commissioning serious photojournalism on timely issues.

Fashion photography

An example of fashion photography

Fashion photography is a genre of photography devoted to displaying clothing and other fashion items. Fashion photography is most often conducted for advertisements or fashion magazines such as *Vogue*, *Vanity Fair*, or *Allure*. Over time, fashion photography has developed its own aesthetic in which the clothes and fashions are enhanced by exotic locations and story lines.

History

The Countess in a photo by Pierre-Louise Pierson (c. 1863/66)

Photography was developed in the 1830s, but the earliest popular technique, the daguerreotype, was unsuitable for mass printing.[1] In 1856, Adolphe Braun published a book containing 288 photographs of Virginia Oldoini, Countess de Castiglione, a Tuscan noblewoman at the court of Napoleon III. The photos depict her in her official court garb, making her the first fashion model. [2]

In the first decade of the 20th century, advances in halftone printing allowed fashion photographs to be featured in magazines. Fashion photography made its first appearance in French magazines such as *La mode practique* and *Les mode*. In 1909, Condé Nast took over *Vogue* magazine and also contributed to the beginnings of fashion photography. Special emphasis was placed on staging the shots, a process first developed by Baron Adolf de Meyer, who shot his models in natural environments and poses. *Vogue* was followed by its rival, *Harper's Bazaar*, and the two companies were leaders in the field of fashion photography throughout the 1920s and 1930s. House photographers such as Edward Steichen, George Hoyningen-Huene, Horst P. Horst and Cecil Beaton, and independents such as Yva transformed the genre into an outstanding art form. Europe, and especially Germany, was for a short time the leader in fashion photography.

As World War II approached the focus shifted to the United States, where *Vogue* and *Harper's* continued their old rivalry. House photographers such as Irving Penn, Regina Relang, Martin Munkacsi, Richard Avedon, and Louise Dahl-Wolfe would shape the look of fashion photography for the following decades. The artists abandoned their rigid forms for a much freer style. In 1936 Martin Munkacsi made the first photographs of models in sporty poses at the beach. Under the artistic direction of Alexander Brodovich, the *Harper's Bazaar* quickly introduced this new style into its magazine.

Commercial photography

Commercial photography is photography made or licensed for the purpose of selling a product, service or idea where fine-art photography is created as an end in itself.

Commercial photography, is also often a collaborative effort of any number of people, from two to two dozen, which may include an account executive, art director, stylist, photographic assistants and other specialists. The exception may be still-life product shots, where the photographer may work independently or with only an assistant.

Most commercial photography is assigned by an advertising agency with the selection of the photographer most often being made by the art director, but it may be done by the creative director, account executive or even at the request of the client. Just because a photograph is commercial does not need to be devoid of art. Many fine-art photographers and editorial photographers have done some of their best work for commercial accounts while often the constraint of representing the product literally has been an obstacle to creativity.

Few professional photographers have been able to ignore the commercial field entirely, and most have counted on the income to be gained from these accounts in a short time, to allow them the free time to exercise their creativity on other projects.

Still life

A **still life** is a work of art depicting inanimate subject matter, typically commonplace objects which may be either natural (flowers, game, sea shells and the like) or man-made (drinking glasses, foodstuffs, pipes, books and so on). Popular in Western art since the 17th century, still life paintings give the artist more leeway in the arrangement of design elements within a composition than do paintings of other types of subjects such as landscape or portraiture.

Still life paintings often adorn the walls of ancient Egyptian tombs. It was believed that the foodstuffs and other items depicted there would, in the afterlife, become real and available for use by the deceased. Similar paintings, more simply decorative in intent, have also been found in the Roman frescoes unearthed at Pompeii and Herculaneum. The popular appreciation of still life painting as a demonstration of the artist's skill is related in the ancient Greek legend of Zeuxis and Parrhasius.

Through the Middle Ages and the Renaissance, still life in Western art was mainly used as an adjunct to Christian religious subjects. This was particularly true in the work of Northern European artists, whose fascination with highly detailed optical realism and disguised symbolism led them to lavish great attention on the meanings of various props and settings within their paintings' overall message. Painters such as Jan van Eyck often used still life elements as part of an iconographic program.

Abraham van Beyeren, *Banquet Still Life*, ca. 1660, Los Angeles County Museum of Art.

Still life came into its own in the new artistic climate of the Netherlands in the 17th century. While artists found limited opportunity to produce the religious art which had long been their staple—images of religious subjects were forbidden in the Dutch Reformed Protestant Church—the continuing Northern tradition of detailed realism and hidden symbols appealed to the growing Dutch middle classes, who were replacing Church and State as the principal patrons of art in the Netherlands.

Especially popular in this period were vanitas paintings, in which sumptuous arrangements of fruit and flowers, or lavish banquet tables with fine silver and crystal, were accompanied by symbolic reminders of life's impermanence. A skull, an hourglass or pocket watch, a candle burning down or a book with pages turning, would serve as a moralizing message on the ephemerality of sensory pleasures. Often some of the luscious fruits and flowers themselves would be shown starting to spoil or fade. The popularity of vanitas paintings, and of still life generally, soon spread from Holland to Flanders, Spain, and France.

The French aristocracy of the 18th century also employed artists to execute paintings of bounteous and extravagant still life subjects, this time without the moralistic vanitas message of their Dutch predecessors. The Rococo love of artifice led to a rise in appreciation for trompe l'oeil (French: "fool the eye") painting, a type of still life in which objects are shown life-sized, against a flat background, in an attempt to create the illusion of real three dimensional objects in the viewer's space.

With the rise of the European Academies, most notably the Académie française which held a central role in Academic art, and their formalized approach to artistic training, still life began to fall from favor. The Academies taught the doctrine of "Hierarchy of genres" (or "Hierarchy of Subject Matter"), which held that a painting's artistic merit was based primarily on its subject. In the Academic system, the highest form of painting consisted of images of historical, Biblical or mythological significance, with still life subjects relegated to the very lowest order of artistic recognition.

Paul Cézanne, *Still Life with Fruit Basket*, 1888-90, Barnes Foundation, Merion, Pennsylvania.

It was not until the decline of the Academic hierarchy in Europe, and the rise of the Impressionist and Post-Impressionist painters, who emphasized technique and design over subject matter, that still life was once again avidly practiced by artists. Henri Fantin-Latour is known almost exclusively for his still lifes. Vincent van Gogh's "Sunflowers" are some of the best known 19th century still life paintings, and Paul Cézanne found in still life the perfect vehicle for his revolutionary explorations in geometric spatial organization.

Georges Braque, *Violin and Candlestick*, 1910, San Francisco Museum of Modern Art.

Indeed, Cézanne's experiments can be seen as leading directly to the development of Cubist still life in the early 20th century. Between 1910 and 1920, Cubist artists like Pablo Picasso, Georges Braque, and Juan Gris painted many still life compositions, often including musical instruments, as well as creating the first Synthetic Cubist collage works, such as Picasso's "Still Life with Chair Caning" (1912).

Artists in the United States, largely unburdened by Academic strictures on subject matter, had long found a ready market for still life painting. Raphaelle Peale (1774-1825), eldest son of Revolutionary era painter Charles Willson Peale, was the first American still life specialist, and established a tradition of still life painting in Philadelphia that continued until the early 20th century, when artists such as William Harnett and John Frederick Peto gained fame for their trompe l'oeil renderings of collections of worn objects and scraps of paper, typically shown hanging on a wall or door.

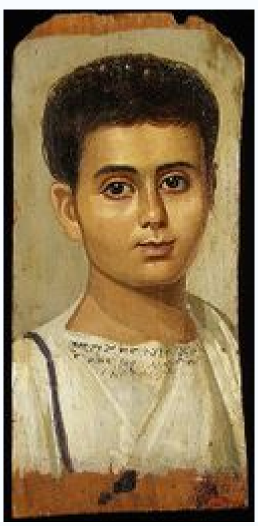
When 20th century American artists became aware of European Modernism, they began to interpret still life subjects with a combination of American Realism and Cubist-derived abstraction. Typical of the American still life works of this period are the paintings of Georgia O'Keeffe, Stuart Davis, and Marsden Hartley, and the photographs of Edward Weston.


A completely synthetic, computer generated still life.

Much Pop Art (such as Andy Warhol's "Campbell's Soup Cans") is based on still life, but its true subject is most often the commodified image of the commercial product represented rather than the physical still life object itself. The rise of Photorealism in the 1970s reasserted illusionistic representation, while retaining some of Pop's message of the fusion of object, image, and commercial product. Typical in this regard are the paintings of Don Eddy and Ralph Goings. The works of Audrey Flack add to this mix an autobiographical Feminist message relating to cultural standards of female beauty. While they address contemporary themes, Flack's paintings often include trompe l'oeil and vanitas elements as well, thereby referencing the entire still life tradition

Portrait

A **portrait** is a painting, photograph, or other artistic representation of a person. Portraits are often simple *head shots* or *mug shots* and are not usually overly elaborate. The intent is to show the basic appearance of the person, and occasionally some artistic insight into his or her personality.



Roman-Egyptian funeral portrait of a young boy

Self-portrait by Vincent Van Gogh.

Some of the earliest portraits of people who were not kings or emperors, are the funeral portraits that survived in the dry climate of Egypt's Fayum district. These are the only paintings of the Roman period that have survived, aside from frescos.

The art of the portrait flourished in Roman sculptures, where sitters demanded realistic portraits, even unflattering ones. During the 4th century, the portrait began to retreat in favor of an idealized symbol of what that person looked like. (Compare the portraits of Roman Emperors Constantine I and Theodosius I at their entries.) In Europe true portraits of the outward appearance of individuals re-emerged in the late Middle Ages, in Burgundy and France.

One of best-known portraits in the Western world is Leonardo da Vinci's painting titled *Mona Lisa*, which is a painting of an unidentified woman. The worlds oldest known portrait was found in 2006 by a local pensioner, Gérard Jourdy, in the Vilhonneur grotto near Angoulême and is thought to be 27,000 years old[1].

Self-portraiture

Self-portrait by Nicholas Hilliard, 1575, one of the earliest known

When the artist creates a portrait of him- or herself, it is called a self-portrait. The first known in paint was by the French artist Jean Fouquet in c. 1450,[2] but if the definition is extended the first was by the Egyptian Pharaoh Akhenaten's sculptor Bak, who carved a

representation of himself and his wife Taheri c. 1365 BC. However, it seems likely that self-portraits go back to the earliest representational art.

Portrait photography

Portrait photography is a popular commercial industry all over the world. Many people enjoy having professionally made *family portraits* to hang in their homes, or special portraits to commemorate certain events, such as graduations or weddings.

Since the dawn of photography, people have made portraits. The popularity of the daguerreotype in the middle of the 19th century was due in large part to the demand for inexpensive portraiture. Studios sprang up in cities around the world, some cranking out more than 500 plates a day. The style of these early works reflected the technical challenges associated with 30-second exposure times and the painterly aesthetic of the time. Subjects were generally seated against plain backgrounds and lit with the soft light of an overhead window and whatever else could be reflected with mirrors.

As photographic techniques developed, an intrepid group of photographers took their talents out of the studio and onto battlefields, across oceans and into remote wilderness. William Shew's *Daguerreotype Saloon*, Roger Fenton's *Photographic Van* and Mathew Brady's *What-is-it?* wagon set the standards for making portraits and other photographs in the field.

Politics

In politics, portraits of the leader are often used as a symbol of the state. In most countries it is common protocol for a portrait of the head of state to appear in important government buildings. Excessive use of a leader's portrait can be indicative of a personality cult.

Literature

In **literature** the term *portrait* refers to a written description or analysis of a person or thing. A written portrait often gives deep insight, and offers an analysis that goes far beyond the superficial. For example, American author Patricia Cornwell wrote a best-selling book titled *Portrait of a Killer* about the personality, background, and possible

motivations of Jack the Ripper, as well as the media coverage of his murders, and the subsequent police investigation of his crimes.

Portraits Vs Photographs

Most people consider photographs as more practical than portraits, yet certain philosophers and writers expressed a sense of nostalgia towards painted portraits. In his novel The Journey of The Fool, Fady Bahig puts on the tongue of his protagonist those words:

... portraits, with their blurred edges fall much closer to the heart of the beholder than photographs with their well-defined edges. Portraits have always given me the feeling of perceiving people as eternal or as manifestations of eternity, as if I have been familiar with them for the whole eternity that preceded my essence.

Burning-in

Burning-in (or simply Burning) is a term used in the photography industry. Burning-in is a technique used during the printing process to darken a specific portion of the print when an enlarger is used to produce the final print. For example, blue skies often appear a dull white in black and white pictures. The printer can burn-in the sky section of the photograph to darken the sky. This often helps to bring out the contrast between the sky and any clouds that may be present.

To burn-in a print, the print is first given normal exposure. Next, extra exposure is given to the area(s) that needs to be darkened. A card or other opaque object is held between the enlarger lens and the photographic paper in such a way as to allow light to fall only on the portion of the scene to be darkened. Since the technique is used with a negative-to-positive process, adding more light to specific areas of the print causes them to become darker.

Ansel Adams elevated burning and dodging to an art form. Many of his famous prints were manipulated in the darkroom with these two techniques. Adams wrote a comprehensive book on this topic called *The Print.*

Many modern digital imaging programs such as Adobe Photoshop have added a "burn" tool which has a similar effect on digital images.

Dodging

Dodging is a term used in the photography industry. Dodging is a technique used during the printing process (using an enlarger) to lighten a specific portion of the print. For example, a photograph may contain unwanted shadows. Dodging can lighten the shadows which can allow more detail in the shadow region to show.

A card or other opaque object is held between the enlarger lens and the photographic paper in such a way as to block light from that portion of the scene to be lightened. The dodged area receives less light and, therefore, less exposure. Less exposure on photographic paper results in a lighter image.

Ansel Adams elevated burning and dodging to an art form. Many of his famous prints were manipulated in the darkroom with these two techniques. Adams wrote a comprehensive book on this very topic called *The Print*.

Many modern digital imaging programs such as Adobe Photoshop have added a "dodge" tool which has a similar effect on digital images.

Retrieved from "http://en.wikipedia.org/wiki/Dodging"

Camera lucida

A camera lucida **is an optical device used as a drawing aid by artists. It was patented in 1806 by William Hyde Wollaston. There seems to be evidence that the camera lucida was actually nothing but a reinvention of a device clearly described 200 years earlier by Johannes Kepler in his Dioptrice (1611). By the 19th century, Kepler's description had totally fallen into oblivion, so that nobody challenged Wollaston's claim. The term "camera lucida" is Wollaston's. (cf. Edmund Hoppe, Geschichte der Optik, Leipzig 1926)**

The camera lucida performs an optical superimposition of the subject being viewed and the surface on which the artist is drawing. The artist sees both scene and drawing surface simultaneously, as in a photographic double exposure. This allows the artist to transfer key points from the scene to the drawing surface, thus aiding in the accurate rendering of perspective. The artist can even trace the outlines of objects in the scene.

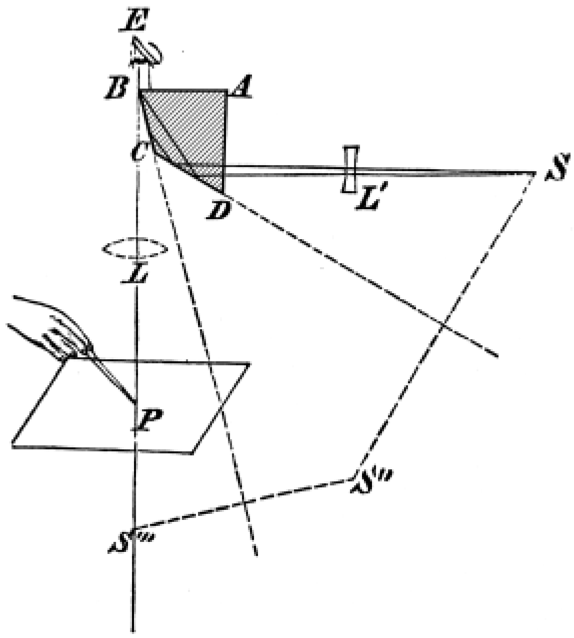
Ca. 1830 engraving of camera lucida in use.

If white paper is used, the superimposition of the paper with the scene tends to wash out the scene, making it difficult to view. When working with a camera lucida it is beneficial to use black paper and to draw with a white pencil.

The camera lucida is still available today through art-supply channels, but is not well-known or widely used. As recently as a few decades ago it was, however, still a standard tool of microscopists. Until very recently, photomicrographs were expensive to reproduce. Furthermore, in many cases, a clear illustration of the structure that the microscopist wished to document was much easier to produce by drawing than by micrography. Thus, most routine histological and microanatomical illustrations in textbooks and research papers were camera lucida drawings rather than photomicrographs.

The name "camera lucida" (Latin for "lit room") is obviously intended to recall the much older drawing aid, the camera obscura (Latin for "dark room"). There is no optical similarity between the devices. The camera lucida is a light, portable device that does not require special lighting conditions. No image is projected by the camera lucida.

In the simplest form of camera lucida, the artist looks down at the drawing surface through a half-silvered mirror tilted at 45 degrees. This superimposes a direct view of the drawing surface beneath, and a reflected view of a scene horizontally in front of the artist. The instrument often includes a weak negative lens, creating a virtual image of the scene at about the same distance as the drawing surface, so that both can be viewed in good focus simultaneously.



Optics of Wollaston camera lucida

The original Wollaston camera lucida, as shown in the diagram to the right, uses an erecting prism. The direct and reflected scenes are superimposed by arranging the apparatus so that only half of the pupil of the eye E views through the prism, viewing the drawing surface P directly. The other half views an erect image of the subject reflected from two sides of prism ABCD. Lenses L and/or L' equalize the optical distances of the viewing surface and subject.

While on honeymoon in Italy in 1833, the photographic pioneer William Fox Talbot used a camera lucida as a sketching aid. He later recorded that it was a disappointment with his resulting efforts which encouraged him to seek a means to "cause these natural images to imprint themselves durably".

In 2001, artist David Hockney created a storm of controversy with his book *Secret Knowledge: Rediscovering the Lost Techniques of the Old Masters.* In it, he suggests that great artists of the past, such as Ingres, Van Eyck, and Caravaggio did not work freehand, but were guided by optical devices, specifically an arrangement using a concave mirror to project real images. His evidence is based entirely on the characteristics of the paintings themselves. His work may arouse fresh interest in the use of optical devices as aids to draughtsmanship.

How to Become a Professional Photographer

Do you want to become a photographer? Or maybe you are thinking about having a photography business? If so, you are in the right place. You need to remember a few things:

Steps

1. Study photography yourself.
2. Practice a lot to get experience. The more you practice, the better a photographer you become.
3. Understand how to shoot using manual exposure - combining shooting speed and aperture. This is the key to photography.

Tips

- Shoot digital. It is convenient as you can see instant results. It is cheap as you won't waste your money buying and processing films.
- Choose a camera with manual exposure, a hot shoe (place where you connect the external flash) and external lights connector in case you want to do professional portraits in the future.

Warnings

- If shooting digital pictures, never delete the images that you have on the card in the computer as the card can become unreadable. Copy your images onto the computer first and then put your card in the camera and delete anything you don't need.

How to Photograph Weddings As an Amateur

Anyone can click away with a digital camera at a wedding, but to do it right, in order, with all the required photographs done efficiently and professionally, takes experience.

Steps

1. Advertise and put yourself out there as an inexperienced photographer looking to learn and take up wedding photography.
2. Approach a professional wedding photographer and ask if you can tag along at a wedding firstly *without* your camera, and assist him (for nothing, although he may throw you a few bucks at the end). The next time, ask if you can take a few reportage or candid shots as long as you don't get in the way of the photographer *or* the proceedings!
3. Approach a couple who are getting married and explain to them that you would like to take photos alongside the professional photographer (for nothing) as practice, and if they like any of your pictures, they can buy them from you at a reduced rate.
4. Go to a wedding and photograph it alone, and just charge for print costs. By not charging, you are limiting your liabilities but getting some incredible experience under your belt. Be careful though, you can become known as the guy who does them for free. It can be hard to break that, especially with distant family and friends.
5. Put yourself on a 2 or 3 day course with a professional photographer and learn about lighting and posing techniques, along with all the other requirements you are going to have to learn. They normally include a model "couple" for a day for you to practice on.

Tips

- Wedding photography is so much more than just taking the photographs, you have to think about the albums, the organising, the printing and above all, your own proficiency, efficiency and professionalism.
- It is a lot to take in and you won't earn money for a while this way, but when you finally start to charge, you will be more than ready and hopefully have bags of confidence.
- Once you get it, weddings can be hard work but an awful lot of fun and very rewarding both financially and satisfactorily.

How to Sell Photos

Not everybody wants to buy a photographic masterpiece. Most people just want to see their loved ones being happy. It's not hard to capture that with your camera if you understand the "Three Classic Elements" of producing salable portraits. Rather than spending countless hours in classes learning every possible detail about photography, you can learn some basics which can get you started actually making money in the business.

Steps

1. Understand the importance of lighting.
   - Photograph happy people whose faces you can readily see. They'll never tell you this at a photography workshop, seminar, or photography institute, but this is what people want to buy.
   - Use soft lighting such as from a flash umbrella or a sunset. Make sure there is enough light to eliminate any shadows and produce a clear photo. You may not win any competitions or awards this way, but if you get plenty of light on the faces, you'll create salable prints.
   - Create bright faces in low-light situations outdoors by using a fill flash. Use a setting on your flash unit that is one less than what is recommended for the current conditions. That will provide just enough light to fill in the shadows without over-exposing your subjects.
2. Arrange the body positioning of your subjects.
   - Avoid photographing your subjects straight on. The exception to this rule will be for families and large groups, for reasons of body placement. The narrower the body area, the more focus will be on the face of your subject. Regardless of whether people are standing, seated, or reclining on the ground, notice the body angle, hands, and feet positions.
   - Turn hands sideways with the fingers together, so that they are less visible. You can also hide them behind someone else in the portrait, if possible.
   - Minimize the amount of leg area seen by crossing at the ankles, if the legs will be visible. This blends the two legs together, and tapers them nicely. If standing, have the person place one foot in front of the other in such a way that the legs are seen as tapering into one general area. Have them place their weight on the back leg (remember, they are at a slight 3/4 angle) and bring the front leg forward, tilting the foot slightly to face out towards the camera.
   - Have subjects tilt their head slightly. A woman alone should tilt her head just slightly in either direction, while men can stay straight up or tilt slightly away in the opposite direction from the most forward shoulder.
3. Develop a good eye for composition.
   - Keep everybody's head at a different level. In some cases, you will recognize that it's not possible, but if you do your best to stagger head height from individual to individual, you will create professional-looking images.
   - Have people stand, sit in chairs, on the arms of chairs, or on the floor. Get others to kneel, crouch, and even lay down.
   - Tip heads inward toward one another for unity when photographing a family group, and note that men are usually positioned higher than women. Believe it or not, the images where mom is sitting higher than dad don't sell as well as the reverse.

Tips

- "Salable" is an industry term which every photographer quickly becomes familiar with. It distinguishes between the everyday reality of earning a living from the process of creating "artistic" or "award-winning" prints which often don't earn much money.
- Notice what elements of your photos appeal to people. Ask them why they chose the particular prints that they buy. The more you understand about your work and what your customers like, the easier it will be for you to play around and have some fun while you're producing salable prints.
- Don't believe that you need to know every possible detail about how to make perfect pictures before you begin. The typical amateur photographer makes this fatal mistake and therefore never proceeds into the business until everything is "perfect" which is unnecessary in order to please the average portrait client.
- Go out, find some customers and get started. Learn from your mistakes and grow your business.
- In addition to creating your own website or portfolio, there are services such as Fotolia where you can sell royalty-free photos by commission to a broad audience.

How to Shoot Slide Film Nature Photography

Not everybody is a professional photographer. Most people just want good pictures. It's easy to capture nature with your camera if you understand the "basics" of how to shoot slides. You could easily spend countless hours delving into the details of slide photography.

Steps

1. Understand the importance of light. The biggest difference between your shot of a beautiful piece of scenery and a professional nature photographer's shot is that the pro was probably waiting for hours to find exactly the right sort of light.
2. Having a good tripod will make all the difference in your nature photos. MAny times, brilliant colors come from waiting until the sun is mostly set and taking a long exposure.
3. Slide film or E6 comes in many flavors and brands. Most nature photographers shoot either iso 50 or iso 100 films.
4. Avoid direct sunlight into the lens. Subjects such as Alpine Lakes are best shot in early morning and early evening. Also known as the golden hour. Most mountain landscapes can be shot between 9am and 12 noon during summer months,for example.
5. Develop a good eye for composition. Composition is another important part of any photography but especially nature photography. The basic three parts to a good composition are: foreground, middle ground and a background subject. For

example, this can be grass or flowers, a lake for middle ground and a mountain as the background. Try not to shoot a lake or mountain by itself. Try to include other elements. Experiment a little!

Tips

- "E6" is an industry term for how most slide films are developed. For best results, store your slide film in a refrigerator at around 59 F before you take it out on a shoot. After the shoot put it back in. Slide film is sensitive to heat and this will ensure longer life and help to preserve those vibrant colors you spent hours capturing, although in the past 20 years, slide films have become progressively less sensitive to heat.
- You are not required to shoot at the speed the film says on the box. Some folks shoot Velvia 50 at 40. Some folks shoot Velvia 100 at 80. Some folks shoot Kodachrome 64 at 80. It depends. Sometimes, you'll have a different speed depending on which color you are trying to draw out. Your best bet is to shoot
- The film you choose has a great effect on your colors. Velvia 50 and Velvia 100 are well-known for providing easy access to brilliantly saturated colors. Velvia 100F is not nearly as saturated. Kodachrome 25, which is now discontinued, and Kodachrome 64 will saturate the oranges and reds, but not so much the other colors. Kodak E100VS has often times the same saturated colors as Velvia, but the blacks aren't always as good. Provia and E100G aim to be more "true to life".

Things You'll Need

- Basic 35mm SLR Film Camera, Lenses, Tripod, Remote and Slide Film.

How to Take Better Photos With the Equipment You Have

Many people think buying expensive camera equipment will make them better photographers. The truth is, it takes time and effort -- not more gadgets -- to improve your skills. Here's my personal path to better shooting.

Steps

1. Go to the public library and get a pile of National Geographic magazines. They feature some of the best photography ever done. Study the techniques and analyse how the pictures are made.
2. Pretend you're a professional photographer and give yourself assignments. Examples: "show how cold it is outside today"; "show motion using both flash and ambient light"; "make someone look menacing in a portrait".
3. Get out a bunch of photos you've taken and crop them in different ways. Place the subject in various positions in the photo and see how it affects the image.
4. Train yourself to shoot a subject from at least three points of view. For example, if you are shooting a person, take a head-and-shoulders portrait, an environmental portrait, and a portrait from an unusual angle.
5. Watch movies. Film directors spend a lot of time setting the mood with lighting, and the same effects can be used in still photography.
6. Shoot lots and lots of film or digital images -- ten times what you'd normally shoot. Never delete or throw anything away. Archive everything so you can find it again. Periodically go back and review what you've done and ask yourself how you could have done better.
7. Repeat above until you are Richard Avedon ;-)

How to Be Photogenic

Do you dislike having your picture taken because you always seem to come out looking hideous? Have you ever been on a date with someone whose online photo knocked you out but whose appearance in real life turned out to be a bit uninspiring? What’s the deal with pictures? While being photogenic just comes naturally to some people, there are a few things that anyone can do to look better in photos. Try out the tricks in this article and stop running for cover whenever the camera comes out.

Steps

1. Wear clothes with colors that suit you. Certain colors complement certain skin tones, while others tend to bring out the worst. Also take into consideration your hair color. You may have a feel for which colors you look best in, but if not do some research (check out the external links below) and some trial-and-error.
2. Hide your blemishes. The bad thing about photographs is that because they are simply frozen images of one angle in an instant in time, they can’t show all your good attributes. The good thing about them is that you can easily hide certain features you don’t like. If you’ve got a unsightly look on one side of your face, for example, don’t show the camera that side.
3. Determine your best angle. Beyond the obvious hiding of blemishes, finding the right angle for your face can be a bit more difficult. The best thing you can do is experiment using a digital camera so that you can immediately see the results of each pose. It will very quickly become obvious which angles are most flattering

for you, and you can then use that angle as much as possible in the future. The classic model's pose is to arrange your body 3/4 toward the camera with one foot in front of the other and one shoulder closer to the camera than the other. This isn't the best pose for everybody, however, and it can look a little ridiculous when used in a family photo right next to Uncle Ed.

4. Get rid of a double chin. Tilt your head down slightly and try to position yourself so that the camera is a little above your eye level. This will hide a double chin fairly effectively. You can also put one hand under your chin as though you're resting your head on your hand (keep the thumb side of your hand out of the camera's view, if possible). Don't actually rest any weight on the hand, however, or you will push the skin into an unflattering position. Also try resting your tongue against the roof of your mouth.
5. Stick your neck out. One trick models often use is to present a 3/4 pose to the camera (turn your head so that 3/4 of it is exposed to the camera, as opposed to a full frontal shot) and then lift your neck and slightly tilt your head down, as though you are a turkey sticking its head out (without actually thrusting your chin out). This improves facial definition and helps ameliorate wrinkles and flabby skin.
6. Relax. Many people end up looking odd in photos because they freeze into odd facial expressions with a "say cheese" type of smile on their face. If you're used to having bad pictures taken of yourself, you probably get nervous in front of the camera, and this can make things even worse. If you know a picture is about to be taken, take a deep breath and exhale naturally, relaxing your arms and shoulders. As you exhale, smile or strike whatever pose is appropriate. Don't hold your breath, either in or out, otherwise you'll appear as though you're tense or suffocating. If you see the photo coming too late, don't panic and try to strike a pose. Keep doing what you're doing and try to ignore the camera. It may not turn out perfectly, but you've got a better chance than if the camera catches you quickly trying to change your facial expression. The more comfortable and relaxed you appear, the better the photo will turn out.
7. Think happy thoughts. An unnatural, forced smile can make you look stiff and, frankly, weird. When people are smiling and waiting for a photo to be snapped, their facial muscles can get caught in all sorts of strange positions. To remedy this, try to time your smile so that you don't have to hold it for too long. Also, imagine something really funny (don't be afraid to laugh a bit, even) or think of someone—your spouse or child, for example—who makes you happy. By doing so, you'll get a genuine smile. If you don't like your smile or your teeth, try a more subdued, closed- or partially-closed-mouth smile. Regardless of how you choose to smile, the happier and more relaxed you are, the better.
8. Smile with your eyes. Nothing projects happiness and beauty like smiling eyes: a happy, somewhat mischievous expression of the eyes. To achieve this effect, imagine that the camera is a person you have a crush on walking into the room. This will create wider open eyes and a relaxed smile. Chances are you unconsciously do this all the time; the trick is to be able to bring it out on demand, so practice the smiling eyes in front of a mirror.

9. Listen to your mother. Remember how mom always told you not to slouch? Good posture can dramatically improve your appearance in pictures. Sitting or standing up straight will make you look healthier and more alert and, if in a group setting, more attractive than your slouching companions. Just remember to breathe normally and relax your shoulders. Especially if you usually have bad posture, it may be difficult to stand up straight and not look stiff, so practice this in the mirror.
10. Get a better photographer. Professional photographers generally know how to bring out the beauty in people. You can’t always choose your photographer, but sometimes you can. If you’re going to put up a shot for an online dating service, consider enlisting a professional. If you need headshots for modeling, get the best professional you can find.
11. Edit or enhance photos. If you’ve tried everything, but you still can’t seem to get a good picture of yourself, try slightly altering your digital photos. Changing the lighting effects or filter effects, for example, can dramatically improve the appearance of your complexion.
12. Fake it till you make it. People are often photogenic because they like having their picture taken. They are therefore relaxed and happy when the camera appears. If you cannot muster up genuine love of the camera, pretend you like the camera-imagine the camera is someone you love, a long lost friend, a old flame, your child at age three, whatever you need to look at the camera lovingly. Try it, it really does work.

Tips

- Study pictures of models and other photogenic people. When comfortable for your personality, experiment with mimicking their postures, but remember most model photos are not what family members or friends are looking for in a picture. Stand at a slight angle to the camera.
- When in a seated group shot, be sure the chairs are placed as close together as possible. Instead of leaning in, sit up straight and relax.
- Have your close friends look at the pictures you've taken to help you ascertain when you look your best. Sometimes, a critical second set of eyes is a great help.
- Consider that people with highly animated faces stand a better chance of getting captured during a transient grotesque expression. Frame-by-frame video is a great way to see significant differences between the photogenic and the not-so-photogenic.
- Practice smiling in front of the mirror. In no time you'll know which smile looks fake and which is the most flattering. Learning how your face moves will help when someone grabs for the camera.
- Keep your tongue behind your teeth.
- Use makeup. Those runway models and movie stars don’t necessarily all have perfect complexions, but they do all wear makeup so that they look unblemished.

Especially if you have oily skin, a spotty complexion or a lot of wrinkles, experiment with different cosmetics to hide the “bad" and accentuate the “good".
- Always look slightly above the camera when the picture is taken. Jacqueline Kennedy Onassis always used this technique for photographs and portraits. Additionally, it helps reduce the "red eye" effect.

Warnings

- Make sure your photos look like you. These steps can help you better capture your natural beauty in pictures, but if you end up doctoring your photos too much you’re liable to look like someone you’re not. While you want to put your best face forward for online dating sites or acting headshots, you also want to make sure you accurately represent yourself. If you don’t, dates and potential employers may be disappointed.
- Sucking in your stomach will make you appear unattractive because your ribs will poke through the shirt. Worse, it will make you look slightly uncomfortable, which is never appealing.

How to Get Better Travel and Vacation Photos

When the great shoot-from-the-hip street photographer Garry Winogrand was asked how he felt about missing pictures while he reloaded his camera, he declared, "There are no photographs when I'm reloading." So it is with summer vacations: They don't exist unless we photograph them. So to prove you actually did parasail over Peoria or tango in Tahiti, take photographs. To help make sure those photos are as colorful as the anecdotes they inspire, follow these non-technical tips.

Steps

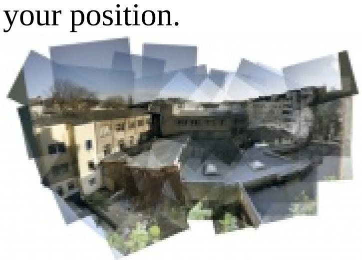
1. Don't unpack your new camera on the way to the airport. Spend at least some time reading the instruction manual, and shoot a roll of film or a memory card as practice.
2. Be adventurous. Approach locals and ask to photograph them as they go about their business. Most people, in my experience, will agree, and you'll end up with better photos and maybe a good story.
3. Don't pose! Let your subjects go about doing their thing rather than stopping them to pose. Occasional portraits in front of spectacular views are great, but more than a few of them are tedious for the subject and your audience.

4. Be inconspicuous. Pack as little as possible. Don't carry a camera bag that looks like one. If you're in a dodgy area, put the camera strap over your right shoulder, under your jacket, with the lens facing toward your body. It's a quick flip of your wrist to bring the camera to your eye with your right hand.
5. Get closer. Use your zoom, or better yet your feet, to fill the frame with your subject and eliminate anything that is distracting.
6. Carry a small notebook and pencil (pencils write in the rain) to jot down the addresses of people to whom you want to send photos.
7. The light is best in the hours just after sunrise and just before sunset, and at those times even mundane scenes can look good. Plan some of your landscape and street-scene photography for those hours. Also, bad weather can lead to good photos, so put on the raincoat and go explore.

How to Make a Panography

Do you ever look up at the sky, a towering office building, or an expansive landscape and wish your photos could capture everything you can see with your eyes? You **can** do this, by creating a panography, taking dozens of photos of a scene and assembling images that represent what your eyes see.

Steps

1. Go out into the world and find something interesting to shoot. Pick your point of view, making sure you can see everything you want to shoot without moving from your position.
2. 

   Click on picture to enjoy the beauty

Manually set the white balance, focus, f-stop, and shutter speed on your camera. This ensures that it doesn't light meter every shot and your photos aren't all differently exposed. If you want your panography to consist of many individual photos, zoom in a bit. If it's your first try, you may want to stay zoomed out so you'll have fewer shots to assemble at the end.

3. Point and shoot. Don't move from your position, but do move your lens in all directions. Try tilting your camera to different angles to soften the straight panorama look. Keep in mind that the more your shots overlap, the easier it'll be to assemble your panography later.
4. Make sure you cover every spot with at least one picture. We tend to only photograph the interesting spots, like lines and busy areas, and oftentimes forget to get the plain areas. Leave a shot out and you'll be left with a hole in your final piece with no way to fill it!
5. 

   Unload your camera and, using Photoshop, resize your photographs (try width or height of 800 pixels). It's tedious to do this manually for each photo; so to expedite the process, record the resizing and saving of one photo as a new Photoshop Action. Then go to File > Automate > Batch to select the new action and apply it to your entire folder of panography photos. This is also where you can select photomerge and have Photoshop do all the work.

6. Create a fairly large new RGB canvas to work on. If it turns out the canvas is too small, you can always add some space later (Image > Canvas). Copy the new 800px versions of your images into your canvas--5 to 10 images at a time ought to be manageable.
7. Set the opacity of each photo to about 50%. Using the Transform function (Ctrl/Apple+T), start rotating each photo to fit the ones next to it. Be careful to make sure you're rotating (you should see a curved arrow tool when you're near a corner) and not skewing the photographs. Now go photo by photo and assemble your panography like a puzzle. It will take a while to get it right, so be sure to save your work as you go along.
8. When you're finished assembling the photos together, make final color, contrast, and levels adjustments. Go to the layer palette and add a new adjustment layer of any kind by clicking the round black/white symbol.
9. To share your panography or post it online, just combine all the layers (Shift+Ctrl/Apple+E), and resize your image. Be sure to save this file separately

instead of overwriting the original, which you'll want to keep in case you want to make changes later.

Tips

- If you want to save the originals, don't forget to duplicate your folder before you resize.
- Submit your creations to the Panography group on Flickr. But be sure to follow the rules if you do:
    - Individual images are not to be skewed or rescaled.
    - The base color is white.
    - The sides are not to be cropped, even if there is one long strand of shots standing out.
    - The images should all have similar color or contrast adjustments for an even look. This is not Techno.
- Microsoft's Digital Image Suite 2006 automates the entire process if you're looking for a faster method.

Warnings

- The more photos you take, the more RAM your computer will need to make the panography. Also, some cameras don't give you the option of manually setting the f-stop and shutter speed. Sometimes one of your preset modes (for example, landscape mode) will keep your settings relatively uniform. Give it a try. If all else fails, automatic mode still works; the effect is just a little different.
- Try not to set the opacity using the "transform" method as this can destroy information (you will not be able to revert this if - even if you wanted to). Rather we suggest that you make sure each photo get's its own layer and you set the opacity for that entire layer to 50% - you can change this as many times as you see fit with no loss of information or extra overhaul to your memory space.

Things You'll Need

- Image manipulating software (Adobe Photoshop CS2, Macromedia Fireworks 8 or GIMP)
- Camera

How to Avoid Your Photo Being a Dark Silhouette

If you've taken photographs that turn out as dark silhouettes with a nicely exposed background, you've got the wrong exposure and it's easy to get it right. This is a common result from excessive backlighting and there are various methods for compensating. The method below assumes you do not have "fill flash" capacity and that your exposure setting is for center of image only, not multipoint exposure metering. On very simple cameras, especially low end digital models, this method should work on the full auto setting (usually a green box on the dial).

Steps

1. Use a camera that allows you to press the shutter button halfway without taking the picture - try it. If you can do this, that's the point where the camera has set the exposure in most "full auto mode" cameras.
2. When the subject (person?) comes out too dark, the camera has looked at the light background and set the exposure to capture that, instead of your subject.
3. Move in close to your subject so that the camera can't see the light background (light background not visible in the viewfinder).
4. If you can't or don't want to go close to your subject - point the camera at the ground IN THE SHADE.
5. Press the shutter button halfway AND HOLD IT THERE.
6. Keep the shutter button half pressed - now move back and frame the picture how you want it to be.
7. Now press the shutter button all the way and take the picture.
8. Your subject will be correctly exposed. The bright background will almost certainly be over exposed - you can't have it both ways!

Tips

- Snow or the sea will always give you a bright background even if you dont think it will - your eyes will compensate.
- Another way to compensate if to use a fill flash to properly expose both the background and the foreground object. Many newer cameras do this automatically in full auto mode, others require some set up such as setting the camera to forced flash.
- Look around for a better shooting angle to start with so the sun isn't behind your subject. Try to find an angle where the sun is behind / to the side of the

photographer. That way the subjects will be illuminated but not squinting looking into the sun.

Warnings

- Anything that is a reflecting surface will give a bright background and mean that you need to use a half-shutter to set the correct exposure.
- Pressing the shutter halfway down will also lock the focus on most cameras. If you move too close to your subject, when you move back the subject may be blurry

How to Make a Movie

Do you (a) like making movies (even home movies) and (b) suck at it? Well, if you fulfill requirements a and b, you're on the right page.

Steps

1. Decide if you are [a] recording to edit or assemble later (archival video), or [b] editing as you shoot, to view exactly as shot later. This is the most important perspective to understand.
2. Think of a plot. Don't make it too elaborate, nor too simple. You don't want it boring, but you don't want to kill yourself and get lost in the sub-plots.
3. Write the screenplay. That's a hard task. Screenplays have special formats unlike any other, even plays. Unless you know how to write in the proper format, write it like a play script.
4. Gather your cast and find a place and time to shoot it! Home movies will be relatively spontaneous.
5. If you're trying to shoot a blockbuster film, create sets. Use mostly wood and paint.
6. Shoot it. If you can, do multiple takes from multiple angles. It will be more interesting in the end.
7. Take it to your computer--upload the stuff you shot, and edit it. Trim off anything boring. The quicker you cut, the more interesting it gets. Also, remember when I said to use multiple angles? Well here's why: by editing between the angles, you can quickly show multiple things going on in the same scene. Use your editing system's split or razor tool to create smaller clips from multiple shots, and then mix and match. You'll get the hang of it.
8. Export to a digital format, or burn to a DVD.

Tips

- If you are making a horror movie try to avoid the cliche of using kids!
- If you are bad at intros and conclusions, then think of the end first, and begin the movie in the same place, or vice-versa.
- Don't shake the camera. The heavier the camera, the harder it is to do, in some ways. Do strength and muscle endurance training if you want to be a rock solid cameraman.
- Don't pan quickly.
- Don't do fancy camera movements. They're not for you. You would need a steadicam.
- Buy a tripod.
- Add music, but not illegally. In other words, you can put music in, but don't give out copies. Or else you have to use non-copyrighted material.
- This is good basic information.
- Vary the shots for interest, but (again IMHO) vary the type of shots, between wide, medium and close-up. Too many close-ups in a row is disorienting. Start with a wide establishing shot (so the viewers know where they are), then vary medium and close-up shots. Keep strange POV (point of view) shots to a minimum unless you are trying to startle the viewer.
- Sound and lighting are very important: Good sound (easily understanding the person speaking without hearing the photographer breathing, or street noise, as example) is critical. Good lighting makes the video/movie watchable. Excellent "budget lighting" Dusk or early morning, a foggy or overcast day, and shade (but only when there is a darker background).
- Finally, about the "features" of the camera: Play with them all you want (zoom, whatever), *then* start shooting without zooming again.
- Panning (moving the camera side to side): don't. But if you must, pan in wide angle, and have a reason for the pan.
- Also on panning: End the pan on the object of the pan. If you're pan is designed to show the Golden Gate bridge, that is then the reason for the pan. Don't pan back and forth.
- Tilting: Same as panning L to R or R to L, but up and down instead. Try to avoid it- but fine when used sparingly.
- If you are able to, try adding some jokes. It will proof you well.
- When you finish your movie, if you decide not to sell it or anything, put it on a popular video site, and get free feedback from people. Most things on google video or youtube are crappy humor videos anyone could make, but yours will stand out (if yours doesn't look like a crappy home video).

Warnings

- Don't steal ideas when writing the script.

- Make sure that when you shoot it, everyone who needs to be there can attend. They must commit.

Things You'll Need

- A video camera.
- Tapes!
- Batteries--don't run out.
- A computer (both to type a script and to edit the footage)
- An editing system like Premiere, iMovie, Pinnacle, Arcsoft Showbiz, or Windows Movie Maker (free on Win. XP)
- Muvee Auto producer works, but it cuts out stuff without the user ordering that to happen.
- Mac users: You have it made, with the free iMovie program, which opens automatically when you plug in your video camera.
- I would recommend strongly to get a wireless lavalier "mic" for the person who you want to record.

How to Photograph a Dragonfly

This is a fun and ridiculously but enjoyably challenging exercise. Bring along your patience, your love of dragonflies and a good camera :-). This article is based on being an amateur photographer with a good quality camera that has foolproof settings. It's not too technical but focuses more on how to find your subjects, how to focus on them and asking you to think about using dragonflies as a photo subject. Butterflies, damselflies, brilliantly coloured beetles and other insects would also serve as beautiful insect subjects for photos.

Steps

1. G

Dragonfly at Parc Oméga

et your camera. It must be a good quality camera. The faster the shutter speed, the better, as these critters fly like the wind. Also, it needs excellent zoom-in capacities and if you have the capacity to take macro-shots (a little flower symbol on some cameras), then you are set for success. Digital cameras are really the best, as you can toss all those bad shots without a care.

2. Discover where the best dragonflies hang out. Dragonflies love water - clear and unpolluted water. They also like plant cover at the edges of the water (like reeds, lilies, trees etc). But you will also find dragonflies flitting about in a number of other places close to water, like cool forests, mossy embankments, beaches and your backyard. And don't forget your local Botanical Gardens - they often attract dragonflies due to the extensive variety of plants.
3. The real trick is to have patience. Dragonflies are constantly on the move. They dart here and there without stopping much. However, they are often in groups around water, so there are plenty to take photos of. Keep an eye for those that alight on greenery or on a path, the road, objects etc. Spend the first 10 - 30 minutes just watching their paths and alighting spots, so that you can get a really good idea of where to aim your camera.
4. Once you have an idea of where they alight the most, seat yourself as comfortably & as unobtrusively as possible in that area and begin to take aim. Preferably, use a tripod as this will provide a steady image and stability.
5. As soon as dragonflies alight on something, click away, making sure you have already made the adjustments to the camera that are necessary for tiny insects. It is important not to make any fast or obvious movements, as the dragonflies will react immediately and fly off again. Slowly does it, even if this means staying perched over your camera for a time.
6. Zooming in is essential, the closer you can go the better. More dragonfly, less background. If you can't avoid the background, use a good photo program at home to remove it later.
7. Take as many shots as your photo card allows (or your film processing budget). Unless you use a tripod, a lot will likely be blurry or unfocused due to the necessity of having to take a photo so quickly without waiting. With a tripod and a faster shutter speed, you have greater control and the luxury to take less shots.
8. Try different times of the day for varied light effects.

Tips

- See links below for absolutely superb photos of a dragonflies, along with photo-taking suggestions.

- Patience is absolutely key. If you are jittery, excited or impatient, either get a tripod, a shake-control camera or another hobby!
- Try all kinds of weather, rain, shine, windy - nothing phases a dragonfly - except cold winter of course!

How to Choose a Camera

Having trouble deciding what camera to buy? Don't know what camera will fit your needs? Not sure what your needs are? Read this and find out.

Steps

Define your needs

1. Write down what your primary goal is. Why do you need a camera? If all you need is the occasional photo shoot or vacation, then a cheaper model might be better for you.
2. Write down how many times you expect to be using the camera. The more you use it, the more likely you are to upgrade your camera. Buy nice or buy twice.
3. Write down how much you want to spend. This is a good way to guage what quality of camera you will be buying. Don't be afraid to go a little over so that you can get a camera that you will keep much longer.
4. Decide if you want analog or digital. Both types have plusses and minusses.

Analog (film camera): The main advantage of analog is the quality of the picture. You will never get a grainy shot, but you will end up spending more on film and developing it.

Digital: The main advantage of digital cameras is the ability to view the pictures that you have taken. This results in not wasting money on unwanted prints. You can also print, and edit any picture you want. Now days, you can go to kodak or cord camera's website and upload your pictures and they'll send you prints for about 15 cents a pop. This is the better choice if you are an amateur/not incredibly serious photographer.

Point and Shoot or SLR

1. First off, what is the difference between SLR and Point and Shoot.

- Well, point and shoot is just that, you point your camera at the subject, zoom in/out, and push the button and take the picture.
- An SLR camera on the other hand, is the stuff you see photographers using, with the huge telephoto lenses, with this camera you need to adjust aperature speed and focus the camera (unless you get an autofocus camera) almost everytime you

shoot. (you only have to change the aperature speed when you change environments)

1. Look at your needs. Do your needs really match up with what a SLR has to offer? Unless you're really into photography, chances are you don't really need an SLR, not to mention they hit the wallet a little harder too.
2. SLR comes in digital and analog formats. But with digital, you can get point and shoot and SLR combined. Essentially a camera that can do automatic photos, but can also allow you to mess with the settings.
3. If you are not sure about making photography your hobby, get a Point and Shoot with advanced options, such as a high end digital. They are not as expensive as an SLR, but do give you the ability to experiment with different settings.

Compare

1. Visit your local photo store and ask to try out some cameras. With digital you can snap a few shots right there in the store and see how you like it.
    - Is it too complicated? Will you avoid taking pictures because it's a pain?
    - Feel the weight. Is it to heavy to carry around while on vacation?
    - Feel if the camera is comfortable in your hands.
    - Take notes or ask for a brochure so you won't forget what you just had in your hands.
2. Read up on the internet what the pros and cons of the cameras you tried are.

Tips

- Think about the future. If you think you won't be taking pictures as a hobby, but rather just to point and shoot, don't get the most expensive digital SLR camera.
- Be sure to compare a lot. There are lots of websites full of information, reviews and user experiences. Use this to your advantage.
- Don't forget to get accessories. A carrying strap or bag can be a lifesaver when you're carrying your camera around a lot.
- If you take the digital route, ask the salesperson how many pictures you can fit on a given memory card, is this too much or too little?
- It is cheaper to buy a 1 gigabyte stick than two 512's.
- Also, you may want to get a good photo editing software for both types of camera, if you get an analog camera, remember to ask for the CD with your prints. this saves that hassle of scanning, and you can edit and print pictures whenever you need to.